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PUBLISHED BY
THE AMERICAN SOCIETY OF ICHTHYOLOGISTS
AND HERPETOLOGISTS

Copeia *1948, No. 4* *December 31*

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Published quarterly by the American Society of Ichthyologists and Herpetologists, at the Museum of Zoology, University of Michigan, Ann Arbor, Michigan, under the Act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized February 11, 1924. Printed by Ann Arbor Press, Ann Arbor, Michigan.

1948, No. 4 COPEIA December 31

Two New Hylid Frogs from Costa Rica

By Edward H. Taylor

ARBOREAL hylids living in tropical and subtropical forests often are among the last species of the herpetofauna to be discovered. Or, if found, they are usually represented in museums by very few specimens and often by a single type. To account for such apparent rarity, one presumes that their entire life history is completed in an arboreal habitat, and that they rarely or never descend to the earth by choice. Certain species are known to have this mode of life history. There are doubtless many other arboreal forms that await discovery.

A single specimen of an arboreal Nicaraguan hylid was described by Cope as *Hypsiboas miliarius* in 1886. The species is very distinctive, having serrate dermal fringes or flaps along the outer side of the limbs, a strong pollex rudiment, and an elaborate series of elongate papillae on head and body. It is a rather large species, the type measuring 62 mm. From the time of its discovery to the present, a period of more than 62 years, no other specimen has been reported.

A species presumably related to *miliarius* was discovered in Colombia, and described by Dunn (1943) as *Hyla phantasmagoria.* It is known from a single female specimen. A dermal fringe and a strong pollex rudiment are present. The hands and feet are much enlarged.

Two other species were discovered in Costa Rica in 1947 by Richard C. Taylor, both of which would appear to belong to the same group as the two preceding forms. The feet of these are not especially enlarged, but the dermal fringe is present, and the pollex rudiment is distinct in each.

It is indeed remarkable that of the four known species of this group, each is represented in collections by only a single female specimen. I would venture to suggest that the males may be equipped with emergent spines on the pollex rudiments to serve as more effective organs for arboreal clasping. Spines are present in the males of the species of *Plectrohyla,* and one diminutive species of the related genus *Centrolenella* in Costa Rica is likewise equipped with spines.

The two new forms mentioned above are being described in the composite genus *Hyla,* despite the fact that they belong to a group very probably generically distinct from *Hyla.* However the complete partitioning of the genus *Hyla* must await the accumulation of adequate skeletal and preserved materials, and these are not available at the present time.

Hyla richardi, sp. nov.

Type.—Richard C. Taylor No. 761, ♀, collected 2 miles W. of Isla Bonita (The American Cinchona Plantation) on the Caribbean slope of Volcán Poas, Costa Rica, elevation about 6700 ft.; Richard C. Taylor, collector.

Diagnosis.—A large hyla with the skin of head co-ossified with skull; tongue longer than broad, not or scarcely emarginate behind; snout not especially blunt, the canthus distinct; tympanum distinct; outer fingers three-

fourths webbed; toes about four-fifths webbed but reaching the disks only on one side of digits; a serrate fringe on outer side of limbs and outer digits; vomerine teeth between choanae; skin without warts or papillae but minutely shagreened, the minute pustules, visible only under a lens, capped with brown horn; a pollex rudiment but no spine evident in type (female).

Description of Type.—Length 71 mm., probably nearly fully grown; head a rather pointed oval, the front of the snout sloping down to lip; canthus distinct, very slightly rounded; lores broadly sloping, distinctly concave; width of upper eyelid contained in the interorbital distance one and one-fourth times; tympanum distinct, directed slightly upward, its diameter contained in eye diameter one and one-half times; most of the skin of the dorsal surface of the head involved in cranial ossification; a pair of depressions behind skull giving a constricted appearance to head; a well-defined supratympanic fold curving over tympanum and extending back to shoulder; no median elevated area on occiput.

A pair of vomerine elevations bearing seven or eight teeth between choanae, separated from each other by a distance equal to their distance from choanae; palatal groove wanting, the palatal glands opening by an irregular series of small perforations; longitudinal diameter of choanae contained in the distance between them, three and one-half times; pupil horizontal, somewhat diamond-shaped.

Skin above finely shagreened, the tips of the minute pustules capped with brown horn, in some regions producing minute pointed spines (these visible only under magnification); a few indistinct tubercles on forearm; skin on chin nearly smooth; abdomen strongly and uniformly granular as well as two-thirds of ventral area of thigh; a few granules below anus more or less fused on each side, separated by a median groove.

Arms short, upper arm especially short and slender; hands and feet not unusually large; the tibiotarsal articulation reaching to near anterior corner of eye; when leg is folded at right angles to body the heels overlap 4 to 5 mm.; arm with a serrate fringe from elbow to terminal disk of fourth finger; largest finger disks larger than tympanum, the disks wider than long; a well-defined, blunt, pollex rudiment without external evidence of a spine (may be present in male); first and second finger with a rudimentary web (one-fourth); between outer fingers nearly three-fourths webbed; subarticular tubercles rather small, flat, distal one on outer finger single; numerous supernumerary tubercles; palmar tubercle or pad much divided.

Legs moderately slender; a serrate fringe from tibiotarsal articulation to disk of fifth toe; disks on toes smaller than those on fingers, the web reaching or nearly reaching disks on outer side except on fourth toe where the membrane reaches the level of the distal subarticular tubercle; subarticular tubercles small under foot; numerous supernumerary tubercles on sole; inner metatarsal tubercle moderately large, the upper end somewhat free; a small indistinct rounded outer tubercle; heel with two or three conical tubercles.

Color.—In life, nearly uniform lavender brown with very indistinct darker markings; disks on all fingers and toes blue-black; edge of lower jaw bluish black; a narrow line of black on edge of upper lip; throat yellow-

brown with fine purple reticulation; venter and underside of thighs lavender brown with cream marks; under side of hands and feet lavender; no light mark at vent.

In preservative, a faint trace of darker bars is evident on limbs, and there is some black pigment scattered on back; fringe on limbs colored like body.

MEASUREMENTS IN MM.—Snout to vent, 71; width of head, 28; length of head, 23; elbow to tip of longest finger, 37; femur, 32; tibia, 37; foot, 53.

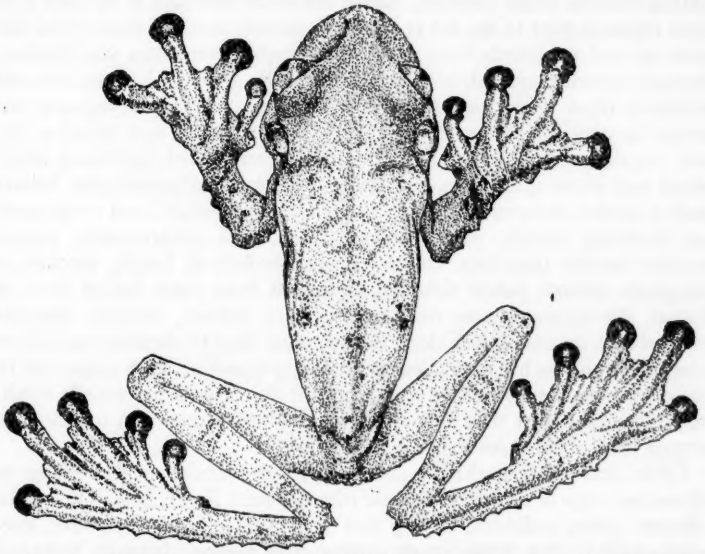

Fig. 1. *Hyla richardi,* sp. nov. Type No. 761, R.C.T. coll. Isla Bonita, Volcán Poas, Costa Rica. × 1. (Slightly diagrammatic.)

REMARKS.—*Hyla richardi* differs from *H. fimbrimembra* and *H. miliaria* in having the derm of the head co-ossified with the skull; in lacking warty tubercles or lamellate papillae or tubercles; in having the surface of back, sides and head covered with minute pustules many, perhaps most, of which are surmounted by minute horny spicules, visible only under a lens, but sensible to touch. The black coloration of the dorsal surface of the digital pads is characteristic. From *H. phantasmagoria* it differs in having much smaller feet and digital disks, and in lacking a casque.

Hyla fimbrimembra, sp. nov.

TYPE.—Richard C. Taylor No. 764, ♀; collected at Isla Bonita (The American Cinchona Plantation), on the Caribbean slope of Volcán Poas, Costa Rica; elevation, 5,200 ft.; Richard C. Taylor, collector.

DIAGNOSIS.—Tongue broader than long, somewhat notched behind; tip of snout rounded, elevated, quadrangular, the canthus somewhat rounded;

tympanum distinct; outer fingers one-half to two-thirds webbed; toes about three-fourths webbed; a strongly serrate fringe on side of outer finger and forearm, and on outer toe and outer side of tarsus to heel; skin of back and limbs tubercular; a pollex rudiment present, pointed and free at tip without spine (spine possibly present in male).

DESCRIPTION OF TYPE.—Type 31 mm. long from tip of snout to vent, not full grown; front end of snout sharply truncate, the nostrils almost directly above edge of lip; area about nostrils swollen, the front edge of snout vertical; canthus rostralis rather rounded; nostril nearer median edge of lip than eye; loreal region sloping to lip, not or scarcely concave; smallest interorbital distance one and one-fourth times width of an eyelid; tympanum very distinct, directed somewhat upward, broader than high, its greatest diameter one and two-thirds times in greatest diameter of eye; a strong supratympanic fold arching up and over tympanum, and continuing to above arm insertion (almost angular on left side); a transverse depressed area, bordering skull, behind and above tympanum, suggesting a constriction immediately behind head; a median elevated oval area from forehead to occiput, and a depressed area bordering eyelids; pupil horizontal, somewhat quadrangular; tongue one-fifth broader than long, free for about one-fifth of length, notched or emarginate behind; palate deflected downward from point behind level of choanae, the palatal groove distinct; two very distinct, rounded, elevated areas between choanae, much closer to each other than to choanae, each about as large as a choana but each apparently lacking vomerine teeth (none can be seen or detected below surface by dissection; this may be a juvenile condition); choanae higher than wide, their longitudinal diameter in the distance between them about three times.

Upper arm rather weak; forearm heavy, with a strong, serrate fringe or fold on back edge of forearm and outer edge of fourth finger; inner finger with a distinct pollex rudiment, the tip free (condition of male unknown; may include spine); first finger much smaller than second; between first and second fingers about one-fifth webbed, a slight fringe extending to terminal pad of first, and more than half length of second; second and third fingers a little more than half webbed, the web with a small smooth fringe reaching to near base of terminal disks; outer fingers two-thirds webbed, web extending beyond level of distal subarticular tubercles; distal subarticular tubercles well developed but rather small; numerous supernumerary tubercles; terminal disks of three outer fingers about equal to (or fourth, a little greater than), diameter of tympanum.

Leg moderate, tibiotarsal articulation reaching to nostril; half webbed between first and second toes; between four outer toes at least three-fourths webbed; diameter of largest terminal disks a little less than diameter of tympanum; subarticular tubercles small, distinct; a well-developed, terminally free, inner metatarsal tubercle; outer tubercle, if present, indistinct; many supernumerary tubercles; a very indistinct inner metatarsal fold; outer metatarsal fold developed into a conspicuous serrate skinfold or fringe extending length of tarsus and outer toe; end of heel with strong, pointed, soft tubercles; heels overlap about 3 mm. when legs are folded at right angles to body.

Skin on back and upper part of sides rather rough with scattered small warts or tubercles that are also present on eyelids, back of head, on exposed surfaces of limbs, and even on sides of head and snout where they are smaller; chin finely and rather indistinctly granular; belly with pavementlike granules; likewise granular under thighs; a thickened glandular fold, divided medially by a groove, below anal opening; from each end of fold a row of conspicuous granules ascend on either side, tending to curve above the vent; opening of vent near upper level of thigh.

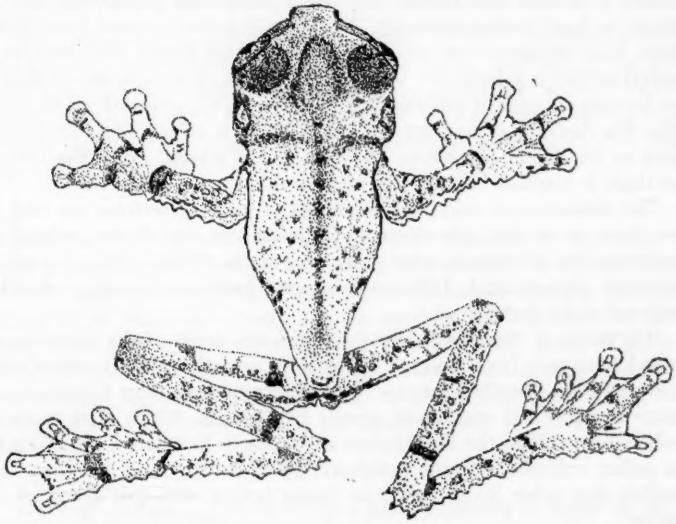

Fig. 2. *Hyla fimbrimembra* sp. nov. Type No. 764, R.C.T. coll. Isla Bonita, Volcán Poas, Costa Rica. × 2. (Slightly diagrammatic.)

Color in Life.—Brownish gray above, the extremities more ashen gray; chin and venter white with strong lavender reticulation on chin; on edge of underside of arm and tarsus a deep lavender stripe; elevated area on head blackish brown; limbs very faintly barred; some small brown flecks forming a short diagonal line on side; some flecks of brown in groin.

In preservative the dorsal color is somewhat lavender brown save that eyelids are dark and a slight median darker mark is evident behind occiput; a distinct blackish band present on wrist; a strong dark band on lower tarsus and one on proximal part of thigh; transverse bands evident on toes; metatarsal and metacarpal areas lighter; a grayish white spot below eye; yellow wash in groin and on part of anterior surface of thigh; around vent a pure white mark with two small black spots above, and with an indefinite darker line running laterally for a short distance on back of thigh; tip of heel white; dorsal surface of disks cream.

Measurements in mm.—Snout to vent, 31; width of head, 12.5; length of head, 11; arm and hand, 18; leg, 52; foot and toe, 24.6; tibia, 17; femur, 15.6.

REMARKS.—The relationship of this species is with *Hyla miliaria* (Cope), a frog from Nicaragua, and with *Hyla richardi* described in this paper. The former is, I believe, known from only a single type specimen (U.S. National Museum No. 14193). I have recently carefully examined the type and compared *fimbrimembra* with it. *Hyla miliaria* has the three outer fingers and the toes completely webbed, while *fimbrimembra* has the outer fingers little more than half webbed, the toes four-fifths webbed. The skin of the head, the back and the limbs is covered with low, warty tubercles, while in *miliaria* the dorsum is covered with leaflike papillae or subspinous projections, most numerous on head above tympanum. The color of *miliaria* is dark plum or mulberry, with obscure coarse reticulations of a darker shade. The color on the ventral surface is yellow. The webs on the feet are plum color except that yellow borders are present and the digits themselves are yellowish on the underside. The dermal processes are often light yellow in color. There are no black spots on the digital expansions. A white spot is present below the vent and the thigh is blackish behind. The tibia is dark.

The differences in color, in the amount of webbing between the toes, and the character of the skin distinctly separate the two forms *miliaria* and *fimbrimembra*. Numerous other differences are in evidence when the two descriptions are compared. Differences between *fimbrimembra* and *richardi* are discussed under that species.

The rarity of these forms has prevented any study of the skeleton, each being known only from the type. It would appear that these together with a fourth recently described species, *Hyla phantasmagoria* from Colombia, constitute a group that may be of generic significance. While *Hyla vasta* and *Hyla lichenata* from the West Indies are similarly fimbriated, the absence of the pollex rudiment suggests a different relationship for these forms. It is possible that other South American forms belong with this group of four species.

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Notes on the Cheat Mountain Salamander

By Maurice Brooks

THE Cheat Mountain salamander, *Plethodon nettingi* Green, was described by Professor N. Bayard Green (1938) from specimens collected by M. Graham Netting, Leonard Llewellyn, Neil D. Richmond, N. B. Green, and myself. All specimens known at that time had been collected in 1935 and 1936 near Barton Knob and Cheat Bridge, Randolph County, West Virginia.

Since then the type locality for the species, and the surrounding region, have received considerable attention from collectors. Netting, Green, Richmond, and others have made visits, and I have collected *P. nettingi* on more than fifty occasions, from April until October. I have summarized the sparse literature dealing with the species, and the notes that follow add to our knowledge of this salamander.[1]

Range

Plethodon nettingi is known only from the high, southern portion of the Cheat Mountains, in Randolph and Pocahontas counties, West Virginia. It has been found from a point along the headwaters of Condon Run, near Bickle's Knob, Randolph County, on the north, to the southern end of the Cheat Range at Thorny Flat, Pocahontas County, on the south. This is an air-line distance of almost exactly 45 miles. Its known altitudinal range is between 3,557 feet at Cheat Bridge, and 4,842 feet atop Bald Knob, Pocahontas County, the highest point in the Cheat system.

The Region

The high, southern portion of the Cheat Mountains is made up of two roughly parallel ridges running generally northeast-southwest. These two ridges, 5-7 miles apart, are separated by an elevated plateau through which runs Shavers Fork of Cheat River. By local usage, the westernmost ridge is known as "Cheat Mountain." The eastern ridge is known variously as "Shavers Mountain" and "Back Allegheny." Both ridges rise continuously above 4,000 feet, and for considerable distances above 4,500 feet. Originally, the whole region was covered with a dense stand of red spruce (*Picea rubens*), with occasional inter-growths of northern balsam fir (*Abies balsamea*). Along Shavers Fork there was a mixture of hemlock (*Tsuga canadensis*) and yellow birch (*Betula lutea*) with the spruce and fir.

Save for fragmentary stands, all of the original timber has been cut since 1900. Because of high precipitation (60-80 inches in the region) and relatively favorable lumbering methods, the area has been little damaged by fire, and it is growing up to a dense forest in various stages from sapling to young timber. All of the higher ridges, as well as stream basins on the plateau, are covered by heavy young stands of spruce.

The northern portion of the region lies within the Monongahela National

[1] I am indebted to Mr. M. Graham Netting, of the Carnegie Museum, Pittsburgh, for helpful suggestions, and for critical reading of this manuscript.

Forest, and so is probably safe from destructive lumbering. The southern portion, however, is still in private ownership, and is subject to severe lumbering operations. Furthermore, it is underlain with two shallow coal veins, and strip-mining is beginning in the region. The future for this high mountain area is not bright.

Habitat

Throughout its range *P. nettingi* appears to be limited to nearly pure stands of red spruce, or to forests in which red spruce is a prominent species. Furthermore, the abundance of the salamander in any given locality is, seemingly, associated with the age of the spruce stand.

The first specimen taken (by Netting and Llewellyn on Barton Knob) was in a spruce log under a dense stand of spruce in the young timber stage. In this locality, repeated collecting, both day and night and at different seasons, has yielded but few additional specimens. Just below the spruce stand (at elevations well above 4,000 feet) is a dense forest of mixed hemlock and yellow birch. Despite much collecting here, not a single example of *P. nettingi* has been found.

Green and Richmond (in 1936) collected to the east of Barton Knob near Cheat Bridge. Eight specimens were taken, after a great deal of work. Most of these were under, or between, rocks.

It was not until collecting was carried out in spruce stands of younger reproduction stages that *P. nettingi* was found in numbers. In May, 1940, Netting, Green, and Richmond took a good series in a dense stand of young spruce in the sapling stage on the summit of Gaudineer Knob, 5 miles northeast of Barton Knob. They also extended the range of the salamander southward to Thorny Flat, where they found *P. nettingi* fairly common in spruce in the young timber stage.

On the night of June 12, 1940, W. A. Lunk and I took a series of 47 *P. nettingi* between 9:15 and 11:30 along a trail 1 mile north of Gaudineer Knob. This trail is bordered by red spruce and yellow birch in approximately equal numbers. Both tree species are in the sapling stage.

Since that time, collectors in young spruce on the Cheat range have been uniformly successful in finding good numbers of the species. At no time has it been found in numbers in mature timber.

Favored localities have sapling or pole spruce in dense stands, either pure or mixed with birch. Under this cover are decaying spruce logs covered with mosses and lichens. On the ground is a mat of spruce needles, and the herbaceous understory is sparse. Boulders and smaller rocks, usually moss-covered, are at the surface, or just below it. The slope may be steep or gentle, and there is no seeming association with stream borders or damp spots.

Seasonal and Daily Activities, and their Correlation with Humidity

During the day, *P. nettingi* is normally found in the moist interior of well-decayed spruce logs. In very damp weather, individuals may be found under bits of log, or under, and between, stones. Just about the time the last thrush notes of the day are echoing through the spruces, the salamanders emerge to the forest floor where they crawl about freely. If the night is cool and exces-

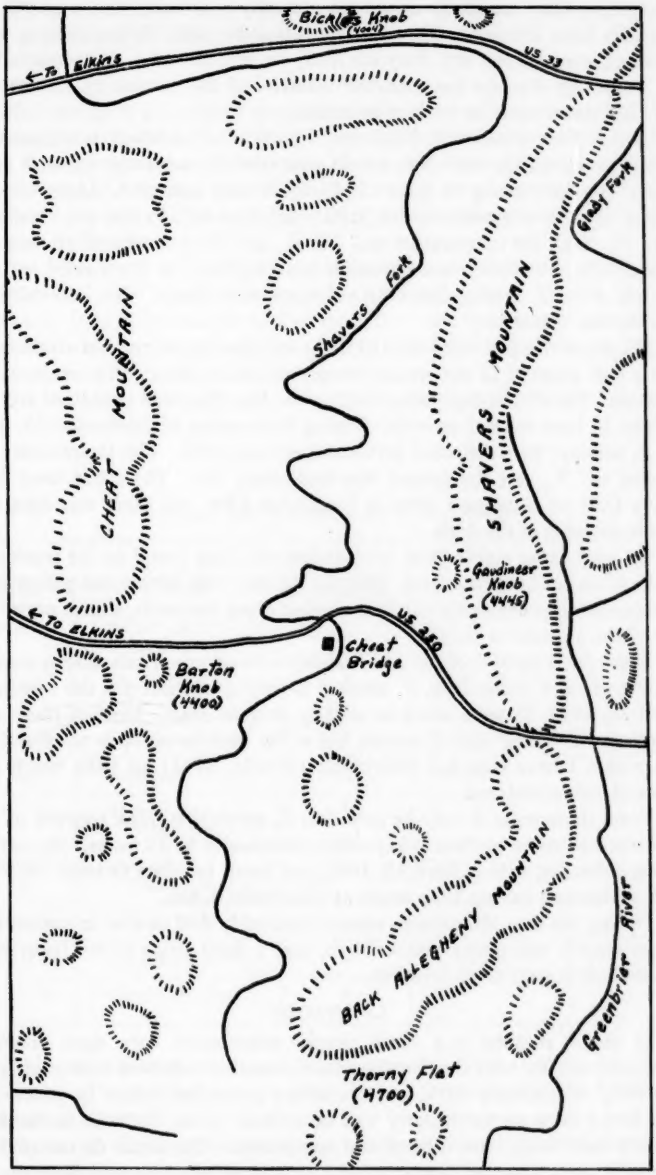

Fig. 1. Range of Cheat Mountain salamander in Randolph and Pocahontas counties, West Virginia.

sively dry, they are likely to remain out only a few minutes, and will customarily have disappeared by the time it is quite dark. If the night is warm, however, even though dry, they are likely to stay out for a considerable time.

I can best describe the nocturnal behavior of the animals by summarizing my field notes made on various occasions:

Notes from Gaudineer Knob and Vicinity.—*P. nettingi* is abundant in mixed young spruce and birch stands near summit and along the trail northward. On the evening of June 12, 1940, 47 were collected. Light rain was falling and the temperature (at 9:00 P.M.) was 64° F. On the evening of July 10, 1940, the temperature was 74° F., and the ground and air very dry. Despite this, *P. nettingi* was abroad in good numbers, and remained out until we left at 9:30. During this time only one other salamander, an example of *P. cinereus*, was seen.

On the evening of April 19, 1941, the weather was warm, but sizable snow drifts still lingered in the spruce woods, and many logs still contained frost crystals. Ten *P. nettingi* were found, 2 in logs that still contained ice. All seemed to have normal activity. During the evening of September 25, 1941, 14 *P. nettingi* were collected between 6:40 and 8:40. The temperature was around 48° F., and the ground was excessively dry. There had been fairly heavy frost on Gaudineer prior to September 25th, and there was light frost on the morning of the 26th.

On very damp nights these salamanders are often found on the trunks and in the branches of spruce trees. Despite the fact that spruce and yellow birch saplings are approximately equal in number along the trails, I have never seen one of the animals in birch.

Notes from Bickle's Knob and Vicinity.—In spruce of mixed ages near the headwaters of Condon Run, *P. nettingi* is very abundant. On the evening of April 24, 1944, 33 were taken in slightly over an hour. Most of these were crawling over mossy logs or stones, but a few were on an open roadbank. In this region I have recorded individuals (Brooks, 1945) on cliffs which held remnant ice formations.

From these notes it may be seen that *P. nettingi* is quite tolerant of dry, cool weather, more so than is any other salamander in its range. My earliest spring collecting date is April 10, 1945, and latest fall date October 19, 1943, both collections having been made at Gaudineer Knob.

During the day, the animals almost invariably find shelter in spruce logs. Green records one under yellow birch, and I have twice found them in or under birch in very damp weather.

Coloration

In life *P. nettingi* is a small, slender salamander, very dark brown in color, and usually with the dorsal surface abundantly flecked with gold spots. The belly is uniformly dark, and the throat somewhat lighter in color. The gold flecks show up particularly well in artificial light. Animals in the field, under a head-lamp, have a burnished appearance. The flecks do not coalesce into solid areas however. An occasional individual lacks the gold flecking, and instead has a rather sparse flecking of white or very light blue spots, more abundant on the sides, and less so on the dorsal surface. After preservation,

these spots of whatever color almost completely disappear. The animals are then uniformly dark chocolate brown on the back and sides.

Breeding

The mating of *P. nettingi* does not appear to have been observed. There is abundant material at hand on the eggs and their numbers and location. Eggs and egg masses resemble closely in size and shape those of *P. cinereus*. The masses are deposited in small crevices in well-rotted spruce logs, and are attached by means of a short pedicel. Eggs are somewhat more yellowish than those of *P. cinereus*.

Egg masses are frequently attended by one, and sometimes by two, individuals. So far as I know, the sex of such attending pairs has not been determined. It is quite unusual to find more than one egg mass in a single log, no matter what its size. I have occasionally found two masses in one log, and once, in a very large log, three.

The following table gives data on the egg masses observed. All masses were in spruce logs.

Table I

Data on Egg Masses of *Plethodon nettingi*

Date	Place of Observation	Number of Egg Masses	Number of Eggs in Masses
5/28/47	Bickle's Knob, Randolph Co.	3	6, 6, 7
6/9/41	Gaudineer Knob, Pocahontas Co.	4	7, 10, 10, 11
6/10/41	Gaudineer Knob	10	8, 9, 9, 9, 9, 10, 10, 10, 11, 14
6/11/41	Gaudineer Knob	2	10, 13
6/12/40	Thorny Flat, Pocahontas Co.	1	8
6/14/40	Bald Knob, Pocahontas Co.	1	10
6/28/41	Bickle's Knob	2	14, 17
7/11/40	Gaudineer Knob	5	4, 8, 8, 10, 11
8/25/39	Gaudineer Knob	1	7

The smallest number of eggs I have seen in a mass is four, the largest seventeen. The earliest date on which I have found egg masses is May 28, the latest August 25.

Green (in the original description of the species) quotes Richmond as having found a mass of eight eggs at Cheat Bridge on July 15, 1936, "in a decayed hemlock log." In view of the usual avoidance of this kind of log by all plethodont salamanders of my acquaintance, his record is remarkable.

Associated Species

Three other species of salamanders are customarily found in association with *P. nettingi.* These are *Desmognathus ochrophaeus ochrophaeus, P. cinereus,* and *P. wehrlei.* All of these frequent spruce logs, although the latter three are not so nearly restricted to this niche as is *P. nettingi.* In the makeup of populations of these four species there are some interesting situations.

In even-age stands of spruce, or spruce and yellow birch, in the sapling stage as on Gaudineer Knob, the other associated species are comparatively much less numerous. Thus, on June 12, 1940, when 47 *P. nettingi* were collected, 2 *P. cinereus* were the only other salamanders found. On June 9, 1941, 50 *P. nettingi* and 5 *P. wehrlei* comprised the collection. On September 25, 1941, the collection consisted of 14 *P. nettingi* and one *P. wehrlei.*

When the spruce is in the pole stage (as on Bald Knob), the four species are in much more equal numbers. In this situation I have found all four within a single log. The denser cover keeps the ground moister, and this apparently favors all members of the association.

When the spruce reaches the young timber stage (as on Barton Knob and Thorny Flat), all of the others are more common than *P. nettingi.* Here the stands are even-aged, the trees about 60 feet in height. The ground is always damp under this heavy cover, and *P. wehrlei* is often the most abundant salamander.

At Bickle's Knob the situation is different, in that the spruce is not in an even-age stand, but occurs in every reproduction stage from seedling to young timber. In this mixed stand all four species occur, and both *P. nettingi* and *P. wehrlei* are abundant. On the night of April 24, 1944, I collected 33 *P. nettingi* and 22 *P. wehrlei* there.

To the east and to the west of the Cheat range there are mountain ridges with remnant stands of spruce. On these the other three associates of *P. nettingi* occur regularly, but fairly extensive search has failed to turn up the latter species.

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Bactericidal Activity of *Crotalus* Venom *in Vitro*

By H. S. Robert Glaser

INVESTIGATIONS into the nature of snake venoms, to date, seem to have been chiefly concerned with the biochemical and immunological aspects of those zootoxins, and most preceding workers, by consequence, have employed procedures developed primarily for problems in those fields. Aside from attempts at chemical analysis and observations of clinical manifestations, efforts generally have been directed toward the detection of the multifarious constituent lytic and other toxic principles of these highly variable proteid mixtures and the determination of minimum lethal doses for numerous metazoan as well as protozoan species (Philpott, 1929). An inquiry to establish a possible bactericidal effect in ophidian toxins, using bacteriological methods, appeared, therefore, as an attractive vista.[1]

A bactericidal action might, of course, be expected in a toxic mixture in which proteolysins and cytolysins are predominant, but I know of no past empirical evidence to substantiate such an inference concerning snake venoms. Fortunately, for the purpose of my studies, the venoms of the locally readily available Nearctic rattlesnakes of the genus *Crotalus* are notorious for their marked proteolytic and histolytic properties—manifested by necrosis in advanced cases of ophidism (Amaral, 1928), and these were consequently deemed suitable for the establishment of a concurrent bactericidal effect.

In this preliminary and purely qualitative study it was intended to compare any bactericidal or bacteriostatic activity of two closely related kinds of toxins, i. e., to observe any selective action as to the venoms of two species of rattlesnakes on certain coccoid and rod, aerobic, bacterial forms.

Methods

Examples of the two species of rattlesnakes (*Crotalus mitchellii pyrrhus* and *C. ruber*) that were to be used in this inquiry had been secured in the field in western Riverside County, California, at between seven to twelve weeks prior to the experimental work, performed in the latter part of April, 1947.

In order to avoid contamination in the process of obtaining samples of venom, a procedure varying somewhat from orthodox usage was adopted. Each specimen of the two species of pit-vipers available was caused to eject its venom into two sterile test tubes—one for each fang (or two temporarily functional, co-maxillary fangs, when so present on one side). The mouths of the tubes were then flamed, plugged, and stoppered and the tubes with their thermolabile contents kept under refrigeration when not in immediate use.

The following forms of bacteria were used as test organisms:

Bacillus subtilis	*Sarcina* sp.
Escherichia coli communis	*Staphylococcus aureus*

[1] I wish to express my gratitude to Miss Bertha J. DuBeau, formerly of Riverside College, under whose supervision this work was undertaken. Dr. Phillips M. Brooks and Messrs. Charles M. Bogert, C. B. Perkins, and Karl P. Schmidt have read early drafts of the typescript and aided me with their friendly, constructive criticisms.

The microorganisms were inoculated from broth cultures into beef agar at 45° C., which was then poured into petri dishes and left to harden. In addition, plates of sterile beef agar, to serve as controls, and of blood agar, to ascertain the expected hemolytic action of the venoms *in vitro,* were prepared.

The venom was then streaked—at a single inoculation for each figure—in the outline of an equilateral triangle, the position of which had previously been marked on the bottom of each dish. The sterile, red hot platinum loop before being dipped into the toxin, preparatory to streaking, was held within the tube containing the venom, about an inch above the viscid contents, for a number of seconds deemed sufficient for the wire to have cooled; such a precaution was thought necessary to avoid rendering the proteids atoxic through coagulation. [2]

The plates were incubated at 37° C. for 48 hours and the comparative qualitative results, i. e., the relative extent of clearness (absence of colonies on and around the area streaked), observed and compared.

Results

Bactericidal activity and dissolution of red cells (hemolysis) *in vitro,* by the toxins of the two crotalid species were respectively positive in every instance noted. In general, the venom of *C. m. pyrrhus* displayed greater activity than that of *C. ruber* on the cultures of the four test organisms as well as on the blood agar plates.[3] This difference was slight, however, and perhaps of little or no significance in the case of *B. subtilis* and *E. coli.* By far the most pronounced action was shown by the toxin of *C. m. pyrrhus* on *Sarcina* sp.; on one of the most distinctive plates, not only the outline of the triangle streaked, but the entire area enclosed by that figure had been cleared. The latter organism also exhibited the greatest sensitivity to the venom of *C. ruber.*

The plates subsequently were kept at room temperature and periodically examined for about four weeks. During this time the areas originally cleared by venom remained free from colonies of the surrounding test microbes. The destructive process that had taken place may, therefore, be termed bactericidal. Whether or not in addition complete dissolution of cells (lysis) had occurred in some instances—as seems likely—was not determined.

Summary and Conclusions

The venoms of *Crotalus mitchellii pyrrhus* and *Crotalus ruber* were tested for bactericidal activity on cultures of *Staphylococcus aureus, Sarcina* sp., *Escherichia coli communis,* and *Bacillus subtilis* and for hemolysis on blood agar. Positive results, varying in degree, were obtained in every instance. Of the two kinds of venoms used, that of *C. m. pyrrhus* appears to possess the more definitive bactericidal and hemolytic activity. The data, although admittedly inadequate for generalizations, suggest that coccoid forms may be less susceptible to *Crotalus* venom than rod forms.

[2] I realize that this method is open to criticism. In the limited time available its chief advantages lay in the facility and speed through which basic qualitative indications of bactericidal activity could be obtained. It is planned to use quantitative methods in more accurately estimating relative activity of *Crotalus* venoms on bacterial growth.

[3] Plates had been prepared in duplicate, and a few in triplicate so that a rough check on the results could be maintained.

As mentioned earlier in this paper, it is most improbable that the bactericidal action of snake venoms is inherent in an individual, component "principle"; more likely such action is correlated with the proteolytic, hemolytic, and general cytolytic properties of these secretions. Adequate chemical analyses of ophidian toxins have so far been impossible because of the great structural complexity of their major proteid constituents. Thus future use of snake venoms in the therapeutics of infections is exceedingly remote.

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An Unusual Variant of *Plethodon glutinosus* in South Carolina [1]

By WILFRED T. NEILL

DURING the summer of 1947 Mr. Robert L. Humphries and I found a colony of peculiar salamanders at a locality about 7 miles north of Tillman, Jasper County, South Carolina. These salamanders in some respects resembled *Plethodon glutinosus glutinosus* (Green) from the Upper Coastal Plain of Georgia and South Carolina, but also showed some interesting divergences from that form in morphology, coloration, habits, and habitat. Special effort was made to collect the unusual salamanders, and eventually 17 specimens were taken, all being found in one small area of creek swamp.

[1] I am indebted to Dr. Sherman C. Bishop for suggestions; to Mr. Karl P. Schmidt for the loan of specimens and for helpful advice; to Mr. Francis L. Rose for many specimens; and to Mr. Robert L. Humphries for assistance in collecting much of the material on which this paper is based.

In all of this series, the head (as viewed from above) is conspicuously wider than the neck. The sides of the head are parallel behind the eyes, and taper abruptly in the eye region to the distinctly truncate snout. Thus the head has a heptagonal appearance. The costal grooves number 15, if 2 that run together in the groin be counted separately. There are 3 costal interspaces between the toes of the adpressed limbs. The tail, when complete and unregenerated, is shorter than the snout-to-vent length in most specimens, slightly longer in a few males. The epidermis of the living specimen is remarkably delicate, coming off in patches almost at a touch. The fascicles of parasphenoid teeth are long and thick. The dorsum is deep black, without trace of spots. The venter is gray with a violet suffusion, the light color extending upward and involving the cheeks. The throat and chin are dirty white, the tip of the lower jaw pale violet. The palms, soles, and the anterior border of the gular fold are also pale violet. The form is slender, the body width of an adult being contained about 7 to 7½ times in the snout-to-vent length. The total length of the largest specimen is 127 mm., which is much above the average. In old males the vent is bordered by a conspicuous fleshy fold. In juveniles the venter is translucent, the viscera and blood vessels showing through the body wall.

Specimens were found only in the vicinity of shrew burrows in thick, damp woods, where the ground was littered with bark scraps, fallen timber, and leafy debris. Throughout the area there was much suitable cover for the salamanders, but none could be found unless the burrows were also present. When disclosed, the amphibians dashed across the debris to dive into the mouth of one of these tunnels. Many thus escaped capture in spite of our best efforts. The tail was quite fragile, particularly in smaller examples. The salamanders gave off a protective fluid when grasped, but the fluid was neither so copious nor so viscous as is usual with *glutinosus*.

In specimens of *Plethodon g. glutinosus* from the Upper Coastal Plain of Georgia and South Carolina, the head is little wider than the neck, and the snout is bluntly rounded. The costal grooves number 16, with 2 costal interspaces between the toes of the adpressed limbs. The tail length consistently exceeds the snout-to-vent length. The parasphenoid patches are long and narrow. The epidermis is not particularly delicate. The dorsum is dotted with white, silver-gray, or cream, and the sides are mottled with large spots or blotches of white or yellow. The venter is intensely black (slate in preservatives), the cheeks heavily spotted but otherwise no lighter than the rest of the head. The ventral surfaces lack any violet suffusion. The body width of adults is contained about 6 to 6½ times in the snout-to-vent length. Old males do not display a fleshy fold bordering the vent; and the venter is opaque in even the smallest examples.

Upper Coastal Plain specimens are not averse to living in shrew burrows, but are by no means confined to such a habitat, being most common in and about decaying hardwood logs on wooded slopes. When disclosed, most examples immediately burrow into the surrounding medium, rarely running along the surface. Few specimens escape an alert collector. The tail is not particularly fragile; the protective skin secretion is copious and viscous.

The unique characters of the Jasper County specimens suggested that

they might represent a hitherto undescribed species. However, Mr. Karl P. Schmidt called my attention to his description of unspotted *Plethodon glutinosus* from the Charleston, South Carolina, area (1924: 67), and Cope's reference to similar examples from that region (1889: 142). Further studies were obviously to be desired; and, accordingly, Mr. Humphries and I made special efforts to secure *Plethodon* series from the critical area. We collected along all the highways in the region bounded by Augusta, Orangeburg, Charleston, and Savannah, stopping to investigate each creek valley or promising stand of timber. Trips were also made to the region above Charleston, as far north as Georgetown, South Carolina; and likewise to Effingham, Chatham, and Bryan counties, Georgia. Sufficient material was obtained to permit a satisfactory analysis of the *Plethodon* population of the area. Specimens from scattered localities were already available in my collection; and in addition, through the courtesy of Mr. Schmidt and the Chicago Natural History Museum, I examined a series of unspotted *glutinosus* from within a 25-mile radius of Charleston. These last had been collected in 1923-24 by Mr. Edward A. Hyer, and had been incorporated in Mr. Schmidt's 1924 paper.

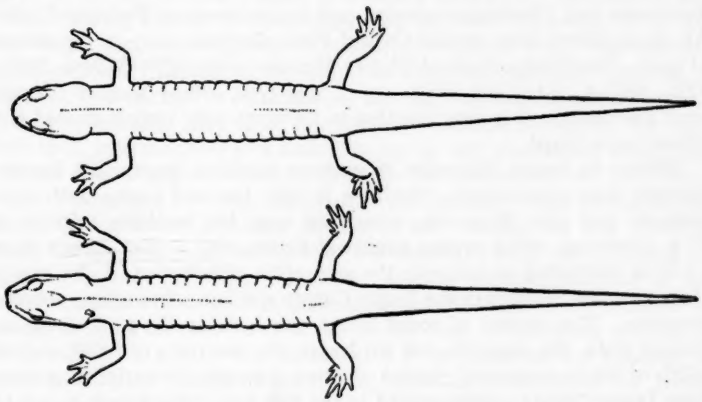

Fig. 1. *Plethodon glutinosus glutinosus,* spotted phase (top), Augusta, Richmond Co., Georgia; unspotted phase (bottom), 7 miles north of Tillman, Jasper Co., South Carolina.

It became evident that the variety of *Plethodon* found in Jasper County, South Carolina, was not present on the Georgia side of the Savannah River, all the specimens from Effingham, Chatham and Bryan counties, Georgia, agreeing with *P. g. glutinosus* from the Upper Coastal Plain. The lower part of the Savannah River, with its extensive marshes and tidal fluctuations, apparently constitutes a barrier to the southward distribution of the unspotted form. It was further evident that the unspotted variety was the only one to be found in central Jasper County; and that the characters of this form were suggested but never completely duplicated in series taken farther north. Specimens from Beaufort County and the southern part of Hampton

County resembled the Jasper County examples in details of morphology and coloration, except that the venter was always dark. Normally spotted *glutinosus* were first encountered in Allendale and Colleton counties, such specimens resembling the Jasper County series, however, in proportions and costal groove count. Some specimens from southern Bamberg County were completely unspotted, but the venter was intensely black and the costal grooves numbered 16. Near Dunbarton, Barnwell County, were found typical spotted *glutinosus* and, in the same area, several individuals with slender form, distinctly truncate snout, a few tiny, scarcely evident dorsal dots, and indistinct, scattered gray lateral spots. These were the only specimens to display an intermediate coloration. Mr. Francis L. Rose, enthusiastic naturalist of Augusta, presented me with 2 specimens, collected on the bluffs of the Savannah River near North Augusta, Aiken County, South Carolina, that resembled the Jasper County type in head shape and body proportions. The dorsal spots were mostly lacking and the lateral spots were reduced in size and number. Other Aiken County examples in my collection are normal *glutinosus*.

Along the coastal regions, unspotted slimy salamanders were noted in Dorchester and Charleston counties, and in southwestern Berkeley County. All these differed from typical Coastal Plain *glutinosus* only in the absence of spots. The Chicago Natural History Museum series (CNHM Nos. 5793-5, 5797, 5807-8, 5816, and 5838) are of this type. Many spotted examples were also taken in this area. Farther to the north only typical spotted individuals were found.

Efforts to collect *Plethodon* in extreme southern Jasper and Beaufort counties were unsuccessful. The area is very low and sandy, with much palmetto and pine flat-woods, presenting very few localities suitable for *P. g. glutinosus*, which prefers hardwood forests with a thick humus layer.

It is interesting to compare the geographic distribution of the various characters that distinguish the Jasper County specimens from those collected elsewhere. The number of costal interspaces between the toes of the adpressed limbs, the proportionate tail length, the stoutness of build, and the width of the parasphenoid patches all form a geographic variation gradient from Jasper County northwestward to the Fall Line. The snouts do not become progressively more rounded in a northward direction, however; one simply encounters progressively fewer individuals with truncate snouts above Jasper County. This type of snout does not predominate anywhere beyond Jasper County, but is occasionally evident even as far north as the Fall Line. In the Upper Coastal Plain a truncate snout seems to be correlated with reduced spotting. In most *glutinosus* the neck is stout and almost as wide as the head, a condition probably correlated with burrowing habits. In the Jasper County type, which apparently is not called upon to excavate its own burrows, the neck is slender, thus making the head appear unusually prominent. Slender necks seemed linked with a reduction or, more frequently, a total absence of spots. An occasional Jasper County specimen exhibited space for a sixteenth costal groove in the axilla; this space or an actual groove was present in individuals taken above southern Bamberg

County. The degree of delicacy of the epidermis is a rather indefinable criterion. Specimens which, upon being grasped, lost flecks and patches of epidermis were found consistently from Jasper County through central Barnwell County. Above this point the examples were usually collected with epidermis intact. Progressively fewer unspotted individuals were noted above Jasper County. An intermediate pattern was found only in a few examples from the vicinity of Dunbarton; these also had a slender form and markedly truncate snouts. Some reduction of spots was evident in the two North Augusta examples, again correlated with slender form and truncate snout. The light cheeks, the light venter, and the concomitant translucency of the venter in small examples were unique characters of the original Jasper County series. A fleshy fold bordering the vent was noted only in a few of this series. These specimens were likewise the only ones to be confined to mammal burrows and the only ones to run actively over the surface when uncovered.

The relationship of the Jasper County type to "normal" *glutinosus* is not easily understood. A somewhat similar situation has been reported in *Ambystoma jeffersonianum,* which in southern Michigan is composed of two forms, differing slightly in morphology and coloration (Clanton, 1934: 1). The ringed and striped phases of *Lampropeltis getulus californiae* are also called to mind (Klauber, 1936: 18). In both these animals crossings of the two types resulted in an abnormal sex ratio, a phenomenon that apparently does not take place in *P. g. glutinosus.* Clanton interpreted the situation in *A. jeffersonianum* as a recombination of two once-distinct subspecies. I do not believe this to be the case in *Plethodon.* It seems to me more likely that the unspotted form is a variant that has developed recently behind the barrier of the lower Savannah River and has radiated out into southern South Carolina; in other words, that the unspotted form represents an incipient subspecies that may eventually replace spotted *glutinosus* in the Lower Coastal Plain. Any interpretation would of course be difficult to prove; it would be safer to conclude merely that certain genes controlling form, coloration, and perhaps behavior of *P. g. glutinosus* are localized in lower South Carolina, their effects being particularly evident in the Jasper County region.

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Effect of Temperature on Development of Scutellation in the Garter Snake, *Thamnophis elegans atratus* [1]

By Wade Fox

ALTHOUGH there seems to have been some feeling in herpetological circles that certain geographic variation in scale characters of reptiles might be due to temperature rather than to genetic differences, no successful experiments have been reported that test this hypothesis. The Pacific coast garter snake, *Thamnophis elegans atratus (see* Fox, 1948; Fitch, 1940: 89), displays an average reduction in certain scale counts northward and coastward from warmer to cooler regions. This race of garter snake occupies a narrow strip of the coast of California from about the Oregon state line to Santa Barbara (Fitch, *loc. cit.).* Because of the trend of scale variation in this form a set of experiments was designed to test the effect of temperature on the scale characters of developing embryos from a carefully studied, homogeneous, local population. Technical difficulties in breeding and raising reptiles made a genetic approach impractical.

Procedure

In late April and early May twenty-four gravid female *T. e. atratus* were collected from an area restricted to 3 miles along the Skyline Boulevard on the San Francisco Peninsula. Examination of numerous other females from the same region showed that female *atratus* had at this time either recently completed ovulation or were nearly ready to ovulate. The females used in the experiments could be recognized as having large yolk-laden eggs by the large size of the body and by actually feeling the individual eggs through the ventral body wall.

The genus *Thamnophis* is one of the genera of snakes that maintains the eggs in the oviduct until the young are fully developed. The experimental problem, therefore, was simply that of keeping the females in good physical condition at the desired temperatures.

The twenty-four snakes were divided into two groups of twelve each. They were kept in 16 x 10 x 11 inch aquaria with three in each aquarium. One group was placed in a room in which the temperature fluctuated from about 65° to 85° F., which will be referred to as the cool room. The other was placed in a room in which the temperature fluctuated from about 75° to 95° F., which will be referred to as the warm room. The temperatures were checked frequently and there was always a 7 to 10 degree difference between the two rooms. Although accurately regulated temperatures were not maintained, the range and fluctuating nature of the temperature of the two rooms gave a rough approximation to the daily temperature rhythms to which these snakes are normally subjected.

The gravid females were fed on new-born rats throughout the experimental period. Due to the greater activity of the snakes in the warm room

1 A contribution of the Museum of Vertebrate Zoology and the Department of Zoology, University of California. The author wishes to express appreciation to Dr. R. C. Stebbins for reading the manuscript and to Dr. J. A. Jenkins for consultation regarding the statistics.

they required more food than those in the cool room. However, the yolk supply of each egg appears to be adequate for the development of the young and differences in feeding habits of the adults should have no effect on the eggs at this time. Field evidence seems to indicate that females heavily laden with eggs feed much less frequently than other snakes, particularly during the last month of pregnancy when their body is expanded considerably with young and enlarged fetal sacs.

Other conditions were essentially the same in the two rooms. Number of daylight hours was approximately the same in the experimental rooms as out of doors at Berkeley during the spring and summer. Light intensity was considerably less than out of doors, but was essentially the same in the two rooms. Relative humidity, of course, differed in the two rooms. However, since the snakes were supplied with bowls of water from which they drank frequently, it seems unlikely that there were any significant differences in the water content of the eggs. All factors except temperature being essentially the same in the two rooms, it was thought that statistically significant differences that might occur in scale characters between the two groups would be due to the effect of different temperatures on development.

For purposes of comparing the experimental broods with the natural population, counts were taken from eight broods (112 individuals) of normally developed young from the same San Francisco Peninsula population. The type of geographic variation of scale characters that is found in *atratus* can be demonstrated by comparing the San Francisco Peninsula sample with a sample from the region of the mouth of the Klamath River in Del Norte County, California. These two areas are both subjected to heavy coastal fog, but the more northern one, Del Norte County, is cooler and cloudier during summer than the latter. Another sample that yielded interesting comparative material was taken from the Berkeley hills on the east rim of the San Francisco Bay. This area has less fog and higher temperatures than the other two areas.

Tests of significance for these data require different methods from those usually applied to taxonomic problems. This is because of the nature of the two experimental groups. These groups are composed of three and eight broods. Because of possible inherited tendencies within each brood it can not be assumed that the entire sample is random nor that the total variation is due to variation between groups. In using Fisher's method of analysis of variance (Snedecor, 1940: 179-248) one can determine the sources of variation and test the significance of each source. Thus it is possible, by using this method and the F table (Snedecor, *loc. cit.)*, to measure the variation of brood means and determine what the probability is that this is due to variation within groups or variation between groups, or to what extent each contributes to the total variation. This type of analysis is extremely important in evaluating these experimental data. In comparing the samples from natural populations chi-square or the *t* test were used (Snedecor: 1940), depending on the nature of the character.

In this paper Snedecor's terminology in stating the level of significance is followed: highly significant—the probability that observed deviations

are due to chance is less than one per cent; significant—the probability lies between five and one per cent.

Results

During the first and second weeks of August eight broods (108 individuals) were born to the females in the warm room. During the first and second weeks of September three broods (28 individuals) were born to the cool room snakes. The number of young from the cool room is disappointingly low, but the reduction in number of scales in some snakes from these three broods is so great that there seems to be little reason to doubt that low temperatures are responsible.

The longer time necessary for development in the cool room is obviously due to the slower rate of development at the lower thermal level. Blanchard and Blanchard (1940) demonstrated that during a cool summer young of *Thamnophis sirtalis sirtalis* were born twenty-nine days later than during a warm summer. Furthermore, there seems to be a correlation in my experimental broods between the length of time of development and the extent of scale reduction.

Two factors were found to be responsible for the failure of several females to produce young. Although large, yolky eggs had already developed in the ovary of some of these females, ovulation did not take place and the normal cycle was interrupted when they were brought into captivity. The follicles in such cases became atretic and were later found to be in various stages of resorption. This seemed to account for all the failures in the warm room and for some of the failures in the cool room. The remaining failures in the cool room seemed to be due to the lethal effects of the low temperatures on the embryos.

The characters that are analyzed in this paper are chiefly those that are used in taxonomic studies. The number of longitudinal dorsal scale rows is of fundamental importance in descriptions of the races of garter snakes. Normally the number of scale rows in this genus is odd, even numbers representing an asymmetrical condition.

Table I

Number of Longitudinal Scale Rows at the Neck

Sample	Number Specimens	Percentage frequencies of counts 17	18	19	20	21
Del Norte Co.	160	3.8	3.1	90.6	0.6	1.9
Cool room	28		3.6	96.4		
Warm room	108			83.3	7.4	9.3
San Francisco	112			89.3	2.7	8.0
Berkeley hills	113			79.6	2.7	17.7

Table I shows that 19 scale rows at the neck is the most common condition found in *atratus*. In Del Norte County there is a slight tendency for fewer than 19 scale rows but rarely more than 19. The cool room experimentals are not significantly different from the Del Norte County sample in this

character. The warm room sample shows a decided tendency to exceed 19 scale rows. This is markedly different from the cool room experimentals but is quite similar to the sample from the natural population of the San Francisco Peninsula. By the method of analysis of variance, the probability that the two experimental samples are from the same population is less than .05. The sample from the Berkeley hills has an even greater tendency toward increase in number of scale rows at the neck, as might be expected in keeping with the hypothesis that the number of scale rows tends to increase at higher temperatures.

It is necessary to examine the number of scale rows at several points along the body. The largest number of rows occurs in the thoracic region.

TABLE II

NUMBER OF LONGITUDINAL SCALE ROWS IN THE THORACIC REGION

Sample	Number Specimens	Percentage frequencies of counts 17	18	19	20	21
Cool room	28	3.6	7.1	78.6		10.7
Warm room	108			10.2	3.7	86.1
San Francisco	112			24.1	4.5	71.4
Berkeley hills	113			26.5	2.7	70.8

Table II discloses remarkable difference between the cool room and warm room experimentals in number of longitudinal scale rows in the thoracic region. This difference proved to be highly significant. The warm room sample is similar to the stock population from the San Francisco Peninsula but is even more inclined toward 21 scale rows than the latter.

The difference between the San Francisco Peninsula sample and the Berkeley hills sample is not statistically significant.

TABLE III

NUMBER OF LONGITUDINAL SCALE ROWS AT MIDBODY

Sample	Number Specimens	Percentage frequencies of counts 17	18	19	20	21
Del Norte Co.	160	3.8		89.3	2.5	4.4
Cool room	28	14.3	10.7	71.4	3.6	
Warm room	108			29.6	3.7	66.7
San Francisco	112			21.4	6.3	72.3
Berkeley hills	113			30.1	0.9	69.0

Nineteen scale rows at midbody are typical for *atratus* from Del Norte County, but a few individuals with more or less do occur. The cool room experimentals have only the slightest tendency to exceed 19 scale rows, but show a striking tendency for 17 and 18 rows. The tendency for the warm room experimentals is in the opposite direction and the difference between the two groups is highly significant (P less than .01). The sample from the Berkeley hills averages slightly less in this region of the body than the San

Francisco Peninsula sample. This is opposite from what we would expect according to our earlier hypothesis. However, the chi-square test shows this difference is not significant.

TABLE IV

NUMBER OF SCALE ROWS AT POSTERIOR END OF BODY

Sample	Number Specimens	Percentage frequencies of counts 15	16	17
Del Norte Co.	160	22.5	4.4	73.1
Cool room	28	39.3	3.6	57.1
Warm room	108	3.7	6.5	89.8
San Francisco	112	2.7	1.8	95.5
Berkeley hills	113	6.2	1.8	92.0

In numbers of scale rows at the posterior end of the body (Table IV), the sample from the cooler geographic area, Del Norte County, averages significantly fewer than the samples from the warmer regions. The cool room experimental sample averages even less than this. The warm room experimentals average appreciably higher than the cool room animals, and this difference is significant (P less than .05). The Berkeley hills sample again has a slightly lower average than that from the San Francisco Peninsula but the differences are not significant.

Two other characters of taxonomic importance are numbers of supralabials and infralabials. In *T. e. atratus* 8 supralabials and 10 infralabials are typical. Occasionally these numbers are reduced by a fusion of two scales or by a combination of three scales to form two. Certain combinations tend to occur more frequently than others. In some the alteration is complete and looks normal, in others the alteration appears as an abnormal fusion. However, in counting the number of labials the taxonomist usually is not concerned with which scale is altered, but merely with the total number. For our purpose it is sufficient to compare the occurrence of the full complement of labials with the occurrence of numbers below this.

TABLE V

AVERAGE (RIGHT and LEFT) PERCENTAGE FREQUENCIES

Sample	Number Specimens	Supralabials 8	−8	Infralabials 10	−10
Del Norte Co.	160	68.6	31.4	51.3	48.7
Cool room	28	42.9	57.1	71.4	28.6
Warm room	108	88.4	11.6	96.3	3.7
San Francisco	112	93.3	6.7	81.7	18.3
Berkeley hills	113	95.6	4.4	88.9	11.1

From Table V it can be seen that a large percentage of snakes possess fewer than 8 supralabials and fewer than 10 infralabials in the Del Norte County and the cool room samples, whereas there are relatively few that

show this reduction in the warm room and the two southern samples. The difference in numbers of supralabials is highly significant for the two experimental groups, but the difference in numbers of infralabials does not prove to be significant. In accordance with our hypothesis the Berkeley hills sample has significantly fewer reductions in labials than the San Francisco Peninsula sample.

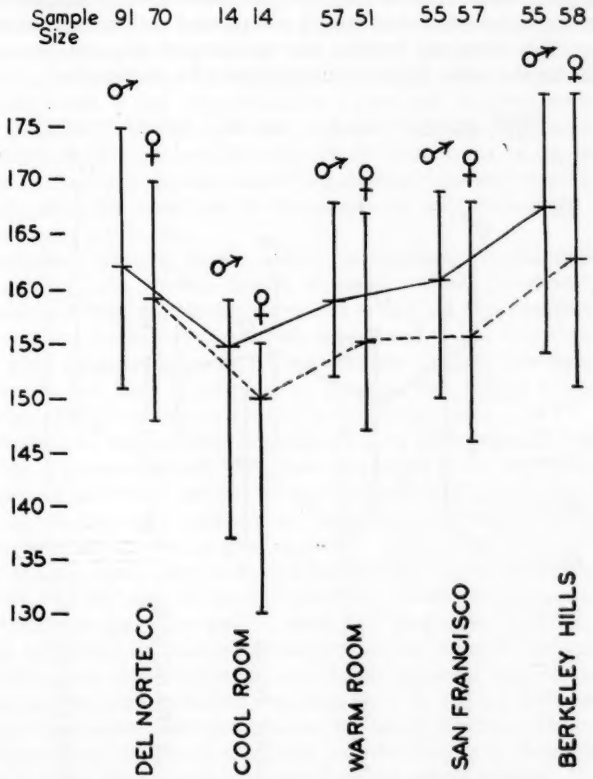

Fig. 1. Variation in number of ventrals, geographic and experimental (see text).

Two characters which are of oustanding taxonomic importance are numbers of ventrals and subcaudals. The ventrals have remarkably low coefficients of variation (Klauber, 1941: 79) as compared to other variable scale characters. There is a pronounced sexual dimorphism in the numbers of ventrals and subcaudals. It is necessary, therefore, to compare the sexes separately. Figure 1 shows the range and mean for numbers of ventrals of the five samples studied. The differences between the cool room sample and the warm room sample are striking in the figure and imply a high degree of significance. By testing with the method of analysis of variance we find

that the P value is only slightly smaller than .05. The explanation for this somewhat low level of significance lies in the fact that there is considerable variation between broods within the two groups, and that the critical data for this character as well as for subcaudals come almost entirely from a single brood of the cool room snakes. This is not true for other characters.

In Figure 1 it can be seen that the San Francisco Peninsula sample averages slightly fewer ventrals than the Del Norte County sample. This is contrary to the contention that there is a northward reduction in the number of scales. This difference between the two samples does not prove to be significant for the males, but is highly significant for the females.

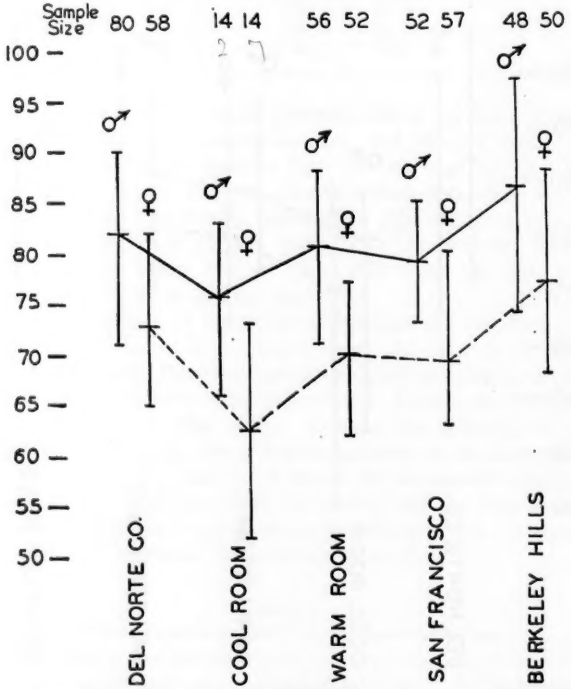

Fig. 2. Variation in number of subcaudals, geographic and experimental (see text).

A highly significant increase in numbers of ventrals over the two coastal samples is found in the Berkeley hills sample. This group conforms by giving the highest counts in the warmest region.

Figure 2 gives the same type of information for subcaudals that Figure 1 gives for ventrals. The general picture is essentially the same. Analysis of variance demonstrates a highly significant difference between females of the cool and warm room samples, but the difference between the males does not prove to be significant. Rather than representing a sexual dimorphism in the degree to which temperature alters number of subcaudals, these data are

merely a reflection of the fact that the brood which has the lower scale counts contains only two males, whereas there are five females. The Del Norte County sample has a significantly greater number of subcaudals than the San Francisco Peninsula sample for both sexes. The Berkeley hills sample exceeds all other samples in number of subcaudals.

Other scale characters are found to be variable in natural populations and show considerable variation in the experimental broods. Preoculars are typically single in *T. e. atratus,* but frequently are divided horizontally. In the cool room sample 71.4 per cent were divided, whereas in the warm room sample only 6.5 per cent were divided. Strangely, this is opposite to the geographic trend. I find them divided in 4.1 per cent of specimens from Del Norte County, 5.8 per cent from San Francisco Peninsula, 14.6 per cent from the Berkeley hills. It is possible that the divisions found in the cool room experimental animals represent something different from the normally divided preocular since the preoculars in this sample are very narrow and crowded against the socket margin.

Postoculars likewise show variation in numbers. Typically there are three on each side. Various fusions or rearrangements occasionally reduce this number in wild populations as well as among the experimentals. In the cool room experimentals 64.3 per cent are reduced to less than three; in the warm room experimentals only 4.1 per cent are reduced. The trend of this variation is the same geographically, although the highest percentage of reduction (Del Norte County sample) is only 13 per cent.

Arrangement and number of temporals vary both naturally and experimentally. The most extreme variations were found in the cool room sample. Variation in number of loreals and postnasals in wild populations is rather rare. In the cool room snakes these variations occur more frequently, but the numbers are too few to give significant results. The types of variation are as follows: loreal may be divided horizontally, loreal and postnasal may be fused, or loreal may be fused to preocular. These two characters are not ones which are generally used in studies of geographic variation, but are usually considered as constant throughout genera or even subfamilies.

Although no color differences were readily apparent between the experimental groups, some attention has been paid to pattern differences. The only obvious pattern difference concerns the lateral blotches. There are more conspicuous irregularities in the shape and distribution of these blotches in the cool room sample than are found in the other samples. Number of blotches varies widely within one population of this species and has not, to my knowledge, been used as a taxonomic character. In the northern population the blotches are very difficult or impossible to count. The number of blotches is not significantly different between the San Francisco Peninsula sample and the Berkeley hills sample. Nevertheless there is a highly significant difference in number of blotches between the two experimental samples. The numbers are fewer in the cool room sample. Number of blotches seems to be correlated with the number of dorsal scales from head to tail which is also correlated with the number of ventrals. It seems likely that the reduction of the number of blotches in these snakes is entirely due to the loss of scales and not directly to the effect of temperature.

Discussion

The small size of the cool room sample upon which the data for this paper rest is unfortunate. However, the statistical analysis to which these data have been subjected shows clearly that most of the differences are statistically significant. Furthermore, that the evidence for reduction of ventrals and subcaudals is chiefly dependent upon one brood weakens its significance. However, other characters are consistently reduced in all three cool room broods. The more extreme reduction of ventral scales in the one brood can possibly be explained by assuming that at the time when the snakes were brought into the cool room the embryos of this brood were younger than the other two and could thus be affected at an earlier, and perhaps more critical, stage of development. That numbers of ventral and subcaudal scutes are determined earlier than other scales seems highly probable. Ventrals of snakes are attached to the ends of ribs and correspond in number to the number of vertebrae (Gadow, 1920: 582). The number of vertebrae would, however, most probably be affected during the time of somite formation, which occurs relatively early in development. The correlation of vertebrae with ventral scales can and should be checked in this experimental material.

What is the probability that this greatly altered brood would have been born in its normal habitat with such small scale counts? From the subspecies *atratus* I have counted scales of over thirty broods of young, comprising nearly 400 individuals, and of over 200 adults. I have examined carefully about 300 other snakes from the population from which the experimental material was taken. In all these snakes there is not the slightest approximation to the small number of ventrals and subcaudals found in the extreme examples among the experimental snakes. Although the male parent of this brood is not known, the female is known, and the number of ventrals and subcaudals of this individual are a few scales in excess of the mean for the sample from the natural population. In view of the above facts there seems to be little reason to doubt that temperature is the factor responsible for the differences between the two experimental groups.

Further support of this hypothesis may be found in the vast quantity of work done on the phenotypic effects of temperature in *Drosophila* and other invertebrates *(see* Goldschmidt, 1938) and in the work dealing with alteration of number of vertebrae in fish by temperature *(see* Gabriel, 1944). It does not seem at all surprising that similar effects could be produced in a poikilothermic animal such as a snake.

The obvious implication of these data that is important to the taxonomic herpetologist is whether such temperature effects actually produce variation in scale characters in natural populations that might be erroneously considered genetical. The data presented here offer no proof for this possibility, but strongly suggest that such can be the case. A few herpetologists have been alert to this possibility and the cautious ones have refrained from giving subspecific status to populations that are differentiated by only average scale differences.

Several examples of geographic trends of scale variation that correspond to temperature trends can be found in the literature. Within the species

Thamnophis ordinoides, as delimited by Fox (1948), there exists a cline from south to north of decreasing numbers of ventrals (Fitch, 1940: 106, Fig. 19). Of this same species Fitch (1940: 99) says that specimens from the Willamette Valley average higher in ventral and subcaudal counts than do specimens from near the coast. Reverse trends also occur. Fitch (1940: 64) says that in *Thamnophis e. couchii,* specimens from the northern end of the range have the highest ventral and subcaudal counts. Bogert (1945) found that in *Salvadora h. hexalepis* and *Salvadora h. deserticola* the number of ventrals is highest in lowland populations.

Klauber (1941) analyzed variation in scale counts of thirteen species of snakes found in San Diego County whose ranges occupied both desert and cismontane areas. He found that ten of these species showed a significant decrease in ventrals from the desert toward the coast. In the other three species one sex or the other showed reverse trends but the differences were below the usual accepted level of significance. Klauber considered humidity to be the outstanding environmental factor that differed between the two regions, but also recognized the importance of temperature differences. He checked other scale characters and numbers of dorsal blotches and rings. None of these showed consistent trends throughout the group. Certain species showed trends that should not be overlooked. *Crotalus ruber* has a significantly higher number of dorsal scale rows toward the coast. *Crotalus m. pyrrhus* has a significantly lower number of scale rows toward the coast. *Salvadora hexalepis, Lampropeltis getulus, Rhinocheilus lecontei,* and *Hypsiglena ochrorhyncha* have a significantly higher number of subcaudals in the desert than in the cismontane region. *Pituophis catenifer* shows the reverse trend. Coastal specimens of *Trimorphodon vandenburghi* average higher in number of supralabials than desert specimens. *Arizona e. occidentalis, Trimorphodon vandenburghi,* and *Crotalus ruber* average significantly higher in infralabials toward the coast. *Pituophis* has the higher number of infralabials in the desert.

It seems important to emphasize that the experimental evidence presented in this paper merely shows that variation in scutellation may be produced by temperature in the subspecies *T. e. atratus,* but this does not prove that geographic variation of scale characters found in this subspecies does not have a genetical basis. In fact, it seems most likely that there would be considerable genetical differences affecting inheritance of scale characters between two such widely separated populations as Del Norte County and the San Francisco Peninsula. Furthermore, the responses to temperature found in this species can not justifiably be applied to any other species. Species, genera, or families may have opposite reactions to temperature, may react to different temperature levels, or may not respond at all within normal temperature ranges.

The data that I present here need to be reinforced, particularly for the cool room broods. They actually present only a crude measure of the role temperature may play. Much detail concerning periods of sensitivity, threshold levels, and time of determination of characters could be obtained by testing these snakes at various, carefully regulated, temperature levels. The complete picture of the interaction of temperature and genes will not be forthcoming until the genotypes of the experimental animals are better known.

SUMMARY

In natural populations of snakes there has been found geographic variation of scale characters that frequently seems to be correlated with differences in temperature or possibly humidity. In *Thamnophis e. atratus* and other species there are reductions in several scale characters from warm to cooler regions. Exceptions to this generalization are numerous.

To test the effect of temperature on scutellation, two groups of gravid females from a localized population of *T. e. atratus* were kept at two temperature levels during the time of embryonic development. Although the number of young born to the snakes of the cooler room were few, it was possible to demonstrate that these snakes had significantly fewer longitudinal scale rows, supralabials, ventrals, subcaudals, postoculars, and lateral blotches than the snakes born in the warm room. Preoculars tended to be divided in the cool room snakes much more frequently than in the warm room snakes, a condition opposite to the trend in the natural populations. For the most part differences between the two experimental groups correspond to differences found in populations that occur in areas of different temperature conditions. This suggests that some of the normal variation found in scale characters might be ontogenetic.

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Early Development of *Pseudacris clarkii*

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THE spotted swamp tree frog, *Pseudacris clarkii* (Baird), ranging from eastern Texas to southern Kansas, has been treated generally as a subspecies of the swamp tree frog, *P. nigrita*, and is so listed in the fifth edition (1943) of Stejneger and Barbour's Checklist. Smith (1947) found breeding populations of *P. n. triseriata* and *P. clarkii* in the same ponds, but without mixing, in areas of overlap in Texas. He inferred that *clarkii* is a distinct species, and has discussed the differences.

Youngstrom and Smith (1936) described the tadpoles of *P. n. triseriata*, as Green (1938) has done for *P. brachyphona*. Descriptions of eggs and tadpoles of some other forms of *Pseudacris* are presented by the Wrights (1929, 1931, 1942).

We collected eggs and adults of *P. clarkii* near Hackney, Cowley County, Kansas, April 26, 1948, in a temporary rain pool. The egg masses were conspicuous and abundant, attached to dead weed stems as shown in Wright's Handbook (1942: 110). By following the development of the more recently laid eggs we obtained an approximate chronology of the embryonic and early larval stages, up to the attainment of definitive tadpole characters.

Comparison with numbered stages of *Rana pipiens* (Shumway, 1942; Rugh, 1948) shows that development of *P. clarkii* up to the time of hatching goes at approximately the same rate, but the change to an active tadpole is then completed more rapidly. For example, the gills had become internal and the operculum was complete at about 4½ days from the presumed time of fertilization in *clarkii* instead of 7½ days (*pipiens*) at 25° C. The growth of the tadpole, however, is much more rapid in *Rana*, for a considerably larger size is reached before metamorphosis.

Another point of interest is the failure of the external gills in *P. clarkii* to become slender and functional. They are covered by the operculum while still in a rudimentary form (Fig. 16). This abbreviation of a step in larval development may be correlated with the reduced size of *Pseudacris* embryos, which are perhaps small enough to permit adequate respiration through the body surface alone.

The changing features of early stages may now be summarized:

24–36 hours (Figs. 1 and 2). Gastrula and yolk-plug. Average vertical diameter of 16 gastrulae 1.28 mm., extremes 1.0–1.66 mm. (measured in life by ocular micrometer). Color pale brown, not heavily pigmented, which would be an advantage in experimental embryology, although the small size is a handicap in manipulation. Wright (1942) gives "citrine drab and ivory yellow" for the animal and vegetal poles, respectively, of the eggs.

50–60 hours (Figs. 3–7 show different individuals of approximately this age). The more advanced embryos of this group have begun to rotate within the capsule (arrow, Fig. 6). Oral sucker protuberances, stomodeum, and gill and heart prominences can be seen.

70–82 hours (Figs. 8–14). In this period myotomes appear, and the first

lateral movements of body and tail begin. The heart starts beating. The eyes become distinct. The stomodeum is more deeply invaginated, and proctodeum can be seen. Two and then three gill rudiments develop. The dorsal surface first shows pigmentation, in the form of scattered black melanophores around the eyes and midlaterally on the trunk. When the total length reaches about 5 mm. (Fig. 14) the larva emerges from the jelly.

100–110 hours (Figs. 15–18). The larva is free, and the rudimentary external gills are quickly concealed by the operculum. Oral suckers persist briefly but are lost as the head and body develop the typical inflated integument. The mouth becomes functional.

130 hours (Figs. 19–20). Food is present in the stomach and intestine, and the cloaca is functional. The heart and liver are reddish, as the blood cells become abundant. The lips are pigmented. In a larva of 142 hours the papillary fringe of the mouth was noted. From this time on, growth is the principal change, with an intensification of pigment, including gold or orange cells, especially on the ventral side. Figures 21 and 22 show a tadpole of about 200 hours, length 10 mm., with limb buds present.

Fig. 23, of the mouth-pad and labial tooth-rows, is from a 12-mm. tadpole, in which these structures have reached definitive form. The pad is fringed with short papillae except anteriorly, where it merges with the surface of the snout. The papillae are in a single row, but with one or two extra submarginals at the lateral edges. The labial tooth-rows stand, as usual, on the crests of integumental folds, through the edges of which the individual horny teeth protrude. Between the folds are deep grooves; these do not show well under a strong light, but have been intensified in the drawing to emphasize their relationship to the tooth-rows. The teeth of the second superior row are separated medially by a fold, under which they seem to disappear. The three inferior rows are unbroken, and diminish progressively in length, the third row being a trifle shorter (16 teeth) than in the published figures of *P. n. triseriata*. The upper and lower mandibles bear minutely serrated edges; these serrations correspond in size and spacing to the tips of individual labial teeth. It may be that these horny jaws are simply tooth-rows in which the members have fused basally and thereby become better fitted mechanically for the work of nibbling, since they are on the jaws proper. Most tadpoles have similar serrated mandibles.

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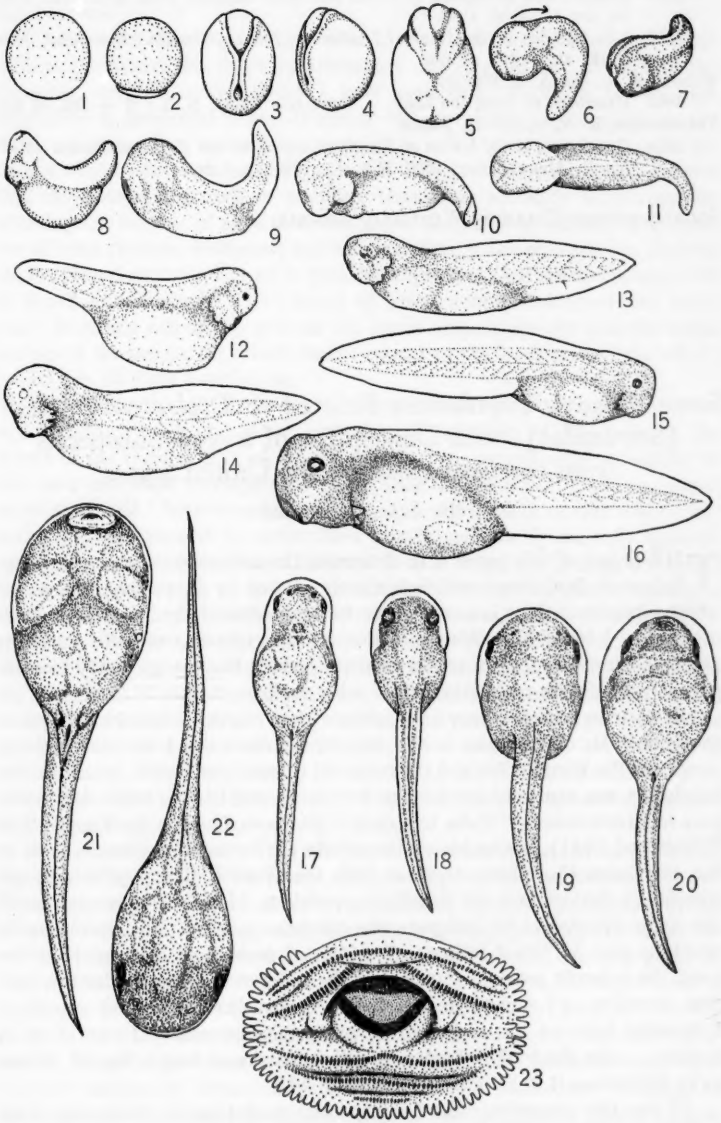

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Some Atlantic Populations Related to *Diplectrum radiale* (Serranidae), with Description of a New Subspecies from the Gulf Coast of the United States

By ISAAC GINSBURG

THE object of this paper is to determine the taxonomic status of a population of *Diplectrum* which is closely related to *D. radiale,* and about which virtually nothing is now known. In my studies of the fishes of the Gulf of Mexico, I found that this population is fairly common offshore along the northern coast, in water of moderate depth, and it became necessary to compare it with similar populations from other regions.

Diplectrum radiale (Quoy and Gaimard) was originally based on Brazilian specimens. Its distribution in the Atlantic, as determined by later authors, comprises the West Indies and the coasts of Central and South America. This conclusion was expressed by Jordan, Evermann and Clark (1930: 318), who gave its distribution as "Cuba to Brazil." However, Longley (in Longley and Hildebrand, 1941), basing his studies chiefly on Tortugas specimens, came to the conclusion that these, together with the West Indian populations, are specifically distinct from the Brazilian population. He accordingly resurrected the name *bivittatum* to designate the northern species, the distribution of which he gave as "West Indies to Florida and probably southward to or beyond the Atlantic coast of Panama." The differences between the two species, according to Longley, are as follows: "Scales [in *bivittatum*] . . . about 8 in series between eye and angle of preopercle, instead of 10 or 11 as in *radiale* . . . also the 3d dorsal spine in *radiale* is twice as long as the 2d, whereas in *bivittatum* it is little longer than the 2d."

Of the two characters that Longley used to distinguish *bivittatum* from *radiale,* the difference in the number of scales on the cheek does not hold in the specimens examined by me, as explained below. The second character, the difference in the relative length of the second and third dorsal spines, does have taxonomic value; but this character needs to be elaborated and Long-

ley's statement amended. The divergence is not as pronounced as that statement implies.

The number of scales on the cheek is often used to distinguish serranid species. However, this is an unsatisfactory character to use, at least in the American serranid species which I have examined, because it is well nigh impossible to determine it quantitatively with precision, as the scales on the cheek are very often irregularly arranged in individual fish. After some experimenting by determining the number of scales in different ways, I decided that the nearest approach to anything resembling accuracy is obtained by counting the number of rows in either one of two ways as follows. The number of rows running downward and forward, that is between the eye and the angle of the preopercle, is 8-10 in some Tortugas and Gulf specimens and 9-10 in Brazilian specimens. The number of rows running downward and backward, including one or two rows on the space between the eye and the upper margin of the preopercle, which do not extend to the lower part of the cheek, is 11-12 in all three populations.

The relative length of the second and third dorsal spines is shown in the accompanying table giving the frequency distribution of the ratio of the length of the third to that of the second. There is considerable variability in this ratio and some overlapping even between the moderate number of specimens measured. Measurements of the spines were made on the whole fish, without dissection, and the determined lengths presumably are only approximate. Another source of error inherent in this character, is that the spines are sometimes chipped at the tip. Specimens showing evidence of having a broken spine were not measured, but this is not always easy to determine.

Three other quantitative characters which are determinable with a greater degree of precision are shown in the table: (1) the number of gill rakers on the lower limb of the outer gill arch, not including 1-4 tubercles that are present at the anterior end of the arch; (2) the total number of outgrowths on the gill arch, including gill rakers and tubercles on both limbs; (3) number of pectoral rays. The divergence in the number of gill rakers between the Brazilian population and that from the Gulf is evidently of species magnitude, while the Tortugas population is intermediate.

An objective perusal of the totality of evidence presented in the table, together with other considerations, offers two possible interpretations: (1) The divergences of the several characters between the three populations are of differing degrees. The Gulf and Tortugas populations nearly agree in the relative lengths of the second and third dorsal spine, while the divergence of the Brazilian population, as indicated by the determined data, would seem to be of species magnitude or nearly so. To a lesser degree, this is so with the pectoral rays. By these two differences, taken in conjunction with the difference in the gill raker count (and perhaps other, minor differences which are not now adequately determinable by the available specimens), it might be concluded that the three populations represent two full species, *radiale* in Brazil, and *bivittatum*, which is divisible into two subspecies, one in Tortugas (possibly including also the West Indies), the other in the Gulf. This conclusion is in essential agreement with that of Longley. (2) The three populations have the same general appearance, their physiognomy is very similar.

While this is an intangible character, it is perhaps legitimate to consider it in the absence of other decisive evidence. Their color pattern is virtually alike. In general, the differences between them appear to be like the usual differences between subspecies of a given species. This is further indicated by the divergence shown in the gill raker count. While the divergence in the relative length of the dorsal spines of the Brazilian specimens is nearly of species magnitude, these specimens are too few for the data to be conclusive. What is even more important, to determine the full taxonomic value of this character it is necessary to study samples from the geographically intermediate populations, those from Venezuela and neighboring regions, which are not now available. Judged by the general experience of the taxonomist, and in consideration of the above discussed points, it is plausible to expect that when a more elaborate study is made, the conclusion will be reached that the three populations here treated are allopatric subspecies of the same species.

The possibility, of course, remains, that even after adequate sampling of all populations the degree of divergence of the Brazilian population will prove to be on the borderline between species and subspecies.

In a more elaborate study of subspeciation in *Diplectrum radiale*, based on a greater number of populations, very closely related populations from the American Pacific coasts should also be included. These were also referred to *radiale* by authors until Meek and Hildebrand (1925: 477) set off the Panama population as a distinct species, *pacificum*. This study deals only with the Atlantic populations available to me, in so far as it is necessary to determine the taxonomic status of the Gulf population.

No matter which one of the above two interpretations is finally accepted there is no question, according to the evidence here presented, that the Gulf population is of subspecific rank and requires a name. However, in using the formal, current nomenclature, we are confronted with a difficulty. According to the first interpretation stated above, it should be designated as *Diplectrum bivittatum arcuarium;* according to the second interpretation the trinomial should be *D. radiale arcuarium*. Therefore, for nomenclatorial purposes, the Gulf population is tentatively treated below as though it were a full species. If we use the modified system of nomenclature previously suggested by me (1947: 275–84), the Gulf population would be designated as *Diplectrum arcuarium*$_2$ which would indicate that it is of subspecific rank without having to commit ourselves as to the final taxonomic treatment of all three populations, for which the evidence is inconclusive or debatable.

Diplectrum arcuarium, new subspecies

D X 12 (11). A III 7. P 15–16. Sc 62–70. GR 11–14.

Dorsal and anal spines and anal rays constantly 10, 3 and 7, respectively, Dorsal rays normally 12, infrequently 11 (in 1 out of 38). Pectoral rays modally 15, often 16. Lower limb of outer gill arch with 11–14 gill rakers (including the one at the angle) and 1–4 tubercles, the demarcation between gill rakers and tubercles usually fairly or well defined; on upper limb the gill rakers grading imperceptibly to the tubercles, or a slight line of demarcation between the two, their combined number 6–8; total combined number of

TABLE I

FREQUENCY DISTRIBUTIONS OF FOUR DISTINGUISHING CHARACTERS OF THREE CLOSELY RELATED POPULATIONS OF *Diplectrum*

Population	Locality	Third dorsal spine divided by second								Gill rakers on lower limb						Total gill rakers and tubercles on both limbs							Pectoral rays		
		1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	8	9	10	11	12	13	14	17	18	19	20	21	22	23	24	14	15	16	17
arcuarium	Northern Gulf Coast	2	6	16	8	3																							
bivittatum	Tortugas	1	7	9	4	1		1					3	1	9	25	4				1	6	14	5	1	2	30	8	
bivittatum	Key West		1											15	8	1					14	2	1			2	14	11	
bivittatum	Puerto Rico			1	1								2	2							2						1	1	
bivittatum	Panama, Atlantic Coast			2	1	1							1							1	1							2	
radiale	Brazil					1	2	3	1	1	1	5	3	3				1	2	4	1	1						4	5

gill rakers and tubercles on both limbs 21–24. First four dorsal spines usually rather evenly graduated in gross appearance; the second two-thirds to four-fifths as long as third; last spine a little longer than penultimate. Preopercle greatly expanded at angle; the expanded part moderately broad, gradually diminishing in width posteriorly, its distal margin rounded; transverse margin of preopercle forming a broad arch to end of expanded part; serrae at middle of expanded part well developed, gradually diminishing in size both ways, the upper serrae directed slightly upward, the lower a little downward; serrae on transverse margin very fine; anterior half of lower margin of preopercle not serrate, smooth or slightly crenate; margin of subopercle and interopercle smooth. Upper caudal lobe (second branched ray from top) usually more or less filamentous, very variable, sometimes excessively so, distance from caudal base to end of filament more than half the standard length, sometimes hardly filamentous. Two longitudinal bands on upper part fairly but not sharply marked in the smaller specimens, becoming more or less interrupted and obscured with growth, and diffusely blending with shadings developing below, above and between the bands; a dark or dusky blotch at caudal base; a black spot on inner surface of opercle, visible externally.

Measurements of holotype, expressed as percentages of standard length: depth of body, 32; depth of peduncle, 12; head (to end of flap), 35; maxillary, 16; snout, 10; eye, 8; interorbital, 7; upper caudal lobe, 28.5; and lower lobe, 22.

Holotype: USNM No. 144213. Pelican Station 5; Lat. 29° 29′ 30″ N, Long. 88° 41′ W; off Breton Sound, Louisiana; 15 fathoms, January 29, 1938.

Other 38 specimens examined from the Gulf of Mexico, ranging from Port Isabel, Texas, to Pensacola, Florida. The depth at which the specimens were captured, those for which such records are available, ranges from 8 to 35 fathoms.

The chief characters by which this subspecies differs from the two most closely related populations are indicated on the accompanying table. Without knowing the locality of capture, it should be possible to identify single specimens of *arcuarium* sometimes, and a sample of about 5 in most other instances.

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Some Changes in the Fish Population of Lake of the Woods, Minnesota, 1910 to 1945

By Kenneth D. Carlander[1]

Evermann and Latimer (1910) recorded 40 species of fishes from Lake of the Woods and its tributary waters. Since that time there have been several changes in the lake and in the fish population. The extensive commercial fishing operations, which were started in the 1880's, are still carried on, but different species support the fishery now than in 1900. Pulp-mill pollution has destroyed spawning areas in the Rainy River, the principal tributary stream. Much of the forest cover has been removed from the watershed and there has been an increase in resorts, boating, and sport fishing.

Lake of the Woods is on the boundary between the United States and Canada. The Canadian portion of the lake, usually known as the "Little Traverse," consists of numerous bays and rocky islands. The shores are mostly rocky and precipitous. In contrast, the southern portion of the lake, the "Big Traverse," is a wide shallow basin about 25 miles across and 35 feet deep. The windswept south shore has extensive sand and gravel beaches, and the only bays on the Minnesota side are small and marshy. The two sections of the lake are almost like separate lakes although broadly joined.

The Minnesota Department of Conservation, in co-operation with the University of Minnesota, initiated a fishery survey of Lake of the Woods in 1939. The catches of several hundred commercial gillnets, pound nets, and fyke nets were examined during this survey. In addition, fish were collected from all types of habitat with minnow seines and with experimental gillnets having meshes ranging from 1.5 to 4.0 inches, stretch measure. The following species of fish were collected from 1939 to 1945:[2]

Northern lamprey, *Ichthyomyzon unicuspis* Hubbs and Trautman.
Rock sturgeon, *Acipenser fulvescens* Rafinesque.
Goldeye, *Amphiodon alosoides* Rafinesque.
Lake trout, *Cristivomer n. namaycush* (Walbaum), seen only from Canadian waters of the lake.
Northern tullibee, *Leucichthys artedi tullibee* (Richardson).
Great Lakes whitefish, *Coregonus c. clupeaformis* (Mitchill).
Quillback, *Carpiodes cyprinus thompsoni* Agassiz.
Common white sucker, *Catostomus c. commersonnii* (Lacépède).
Northern sturgeon sucker, *Catostomus c. catostomus* (Forster).
Silver redhorse, *Moxostoma anisurum* (Rafinesque).
Northern redhorse, *Moxostoma aureolum* (LeSueur).

[1] The author wishes to express his thanks to the many persons who contributed to this study. Special thanks are given Dr. Samuel Eddy, of the University of Minnesota, and Dr. Lloyd L. Smith, Jr., formerly of the Minnesota Department of Conservation, for supervision throughout the study, and to Dr. Raymond E. Johnson, of the Minnesota Department of Conservation, for assistance in preparing this paper and for collecting data in 1945 and 1946. Messrs. Jesse Douglass, Lawrence E. Hiner, and John Dobie aided in the field collections.

[2] Correspondence between the Division of Fishes of the National Museum and the Minnesota Bureau of Fisheries Research yields the interesting information that a considerable collection of fishes apparently was made by S. E. Meek during October-November, 1908, in Lake of the Woods, Canada. Sixty-nine fishes are in the National Museum properly labeled with tin-tags and accompanied with brief identification notes. Among the 18 species is one specimen of *Dorosoma cepedianum* (LeSueur). In the words of Associate Curator Robert R. Miller, "the identification is absolutely certain." Since this is the only record of *Dorosoma* from Lake of the Woods, it probably should not be accepted until there is proof that Meek actually obtained it from there.

Great Lakes longnose dace, *Rhinichthys c. cataractae* (Valenciennes), at Rocky Point on July 15, 1945.

Northern pearl dace, *Margariscus margarita nachtriebi* (Cox), at Rocky Point on July 15, 1945.

Western golden shiner, *Notemigonus crysoleucas auratus* (Rafinesque), in the Northwest Angle inlet on July 15, 1940.

Lake Emerald shiner, *Notropis a. atherinoides* (Rafinesque).

River shiner, *Notropis blennius* (Girard).

Spottail shiner, *Notropis h. hudsonius* (Clinton).

Northern blacknose shiner, *Notropis h. heterolepis* Eigenmann and Eigenmann.

Northern brown bullhead, *Ameiurus n. nebulosus* (LeSueur).

Tadpole madtom, *Schilbeodes mollis* (Hermann), taken at Oak Island, July 13, 1940, and at the mouth of the Rainy River, August 18, 1939, and August 17, 1940.

Northern pike, *Esox lucius* Linnaeus.

Wisconsin muskellunge, *Esox masquinongy immaculatus* Garrard, seen at Oak Island and in Four Mile Bay.

Trout perch, *Percopsis omiscomaycus* (Walbaum).

Eastern sauger, *Stizostedion c. canadense* (Smith).

Yellow pikeperch, *Stizostedion v. vitreum* (Mitchill).

River darter, *Imostoma shumardi* (Girard).

Northern log perch, *Percina caprodes semifasciata* (DeKay).

Central johnny darter, *Boleosoma n. nigrum* (Rafinesque).

Iowa darter, *Poecilichthys exilis* (Girard), collected at Pine Island, at Wheeler's Point, and in the Northwest Angle Inlet. Specimens in breeding colors were taken at the latter location on July 15, 1940.

Northern smallmouth black bass, *Micropterus d. dolomieu* Lacépède, commonly taken around Oak and neighboring islands. A yearling specimen was collected at Long Point on the south shore in 1941.

Northern rock bass, *Ambloplites r. rupestris* (Rafinesque), occasionally taken among the islands and along shore.

Black crappie, *Pomoxis nigro-maculatus* (LeSueur).

Eastern burbot, *Lota lota maculosa* (LeSueur).

One hybrid darter, *Imostoma shumardi* × *Percina caprodes semifasciata*, was collected near Pine Island at the mouth of the Rainy River in 1940 (Carlander, 1941: 43–44; Hubbs, 1945: 20).

Eight species in the above list were not reported from the lake by Evermann and Latimer,[3] namely: longnose dace, pearl dace, golden shiner, madtom, muskellunge, Iowa darter, smallmouth black bass, and rock bass. Two of these, the longnose dace and the rock bass, were reported by them only from tributary waters. The smallmouth black bass was introduced into a Canadian lake in 1901 and escaped into Lake of the Woods where the species has become established (Eddy and Surber, 1947). At least two other species have been introduced into the lake but apparently did not become established. The Minnesota Department of Conservation records show that 1740 bass, presumably largemouth black bass, *Huro salmoides* (Lacépède), were planted in 1925 and an additional 750 in 1931. Sunfish, presumably bluegills, *Lepomis m. macrochirus* Rafinesque, were planted in 1922.

It is probable that except for the smallmouth black bass all of the species here reported were present in the lake when Evermann and Latimer made their collections. The additional species were mostly small fishes. The mus-

[3] The following species were listed by Evermann and Latimer under the indicated synonyms: *Ichthyomyzon unicuspis* as *I. concolor* (Kirtland); *Notropis blennius* as *N. jejunus* (Forbes); *N. h. heterolepis* as *N. cayuga* Meek; and *Imostoma shumardi* as *Hadropterus guntheri*.

kellunge, while taken in some numbers by anglers, is far from abundant and probably would be missed if not so intensely sought. Since the muskellunge has not been reported from Manitoba (Hinks, 1943: 64) and since Lake of the Woods is apparently near the northwestern corner of the range of this species, it is possible that the muskellunge has entered or been introduced into the lake in recent years. The possibility that the golden shiner and the pearl dace were introduced from minnow pails must not be overlooked, but since both species are found elsewhere in the Hudson Bay drainage, it is likely that they were already present in the lake.

Evermann and Latimer listed 12 species not collected during the recent study. Two of these, the western blacknose dace, *Rhinichthys atratulus melagris* Agassiz (listed as *R. atronasus*), and the brook stickleback, *Eucalia inconstans* (Kirtland), were recorded only from waters tributary to Lake of the Woods. Three others were apparently listed on the basis of hearsay or probable range since there was no mention of specimens. These three were: bowfin, *Amia calva* Linnaeus; fathead minnow, *Pimephales p. promelas* (Rafinesque); and northern creek chub, *Semotilus a. atromaculatus* (Mitchill). Surber (1920: 15) and Hubbs (1945: 13) have already indicated that the records for the bowfin were probably the result of confusion with the burbot which is locally called the "dogfish" as is the bowfin.

Hubbs (1945) listed the following four species which Evermann and Latimer misidentified and incorrectly attributed to Lake of the Woods: hog sucker, *Hypentelium nigricans* (LeSueur); redfin shiner, *Notropis umbratilis cyanocephalus* (Copeland); rosyface shiner, *Notropis rubellus* (Agassiz), listed as *N. rubifrons* (Cope); and black bullhead, *Ameiurus m. melas* (Rafinesque).

After eliminating the species from tributary waters, those listed without reference to specimens, and those misidentified, there remain three species which Evermann and Latimer reported which were not found in the recent investigations: mooneye, *Hiodon tergisus* LeSueur; northern common shiner, *Notropis cornutus frontalis* (Agassiz); and bluntnose minnow, *Hyborhynchus notatus* (Rafinesque). They listed the last species without referring to specimens, but Hubbs (1945) found specimens of this species which they had misidentified as *Notropis umbratilis*. Hubbs (1945: 18) also states that two specimens identified as *Notropis blennius* from Rat Portage are actually *N. v. volucellus* (Cope). The northern mimic shiner should be added to the list of fishes collected by Evermann and Latimer but not found in recent years.

Probably of more significance than the additions and subtractions to the list of species is the evidence of changes in the abundance of species since Evermann and Latimer's investigations. Even at that time, they (p. 126) noted that the numbers of rock sturgeon were rapidly decreasing compared to the abundance when commercial fishing first started. Now, the sturgeon is almost extinct. From 1939 to 1944, only seven sturgeon were seen by the field party. One of these weighed about 40 pounds dressed; the others were small, 18 to 30 inches, fork length.

The Great Lakes whitefish was one of the most important commercial

fishes in 1910. It is now uncommon and unimportant in the Minnesota waters, although it is still fairly common in deeper Canadian waters.

It has already been mentioned that the mooneye was not found in recent collections. Only a few goldeyes have been caught in the last few years even though they were listed as common by Evermann and Latimer (p. 132). Commercial fishermen report that the goldeyes began to disappear in 1923, coincident with an increase in tullibee. Neither mooneyes nor goldeyes were ever particularly sought by commercial fishermen.

There has apparently been a change in the abundance of the various suckers. The quillback are no longer abundant, although they are still occasionally taken in some numbers. Only a few sturgeon suckers were seen in the recent survey, and the white sucker is now the more common species although reported by Evermann and Latimer (p. 129) to have been less abundant than either the quillback or sturgeon sucker.

It is also possible that there has been a shift in the abundance of minnows. Evermann and Latimer (p. 130-131) considered the spottail shiner to be the most abundant minnow, but it is now decidedly less abundant than the lake emerald shiner.

The sauger has apparently increased in recent years for it is now one of the most abundant species in the lake, although reported by Evermann and Latimer (p. 135) as "not common."

Without data on environmental conditions and on the fish populations between 1910 and 1939, one can do little but speculate as to the causes for these changes. An analysis of the changes which have occurred in the commercial fisheries as shown by the fishery statistics is now in press.

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Sparidentex hasta (Valenciennes), a New Name for *Chrysophrys cuvieri* Day

By Ian S. R. Munro

In connection with the preparation of a detailed revision of the Australian Sparidae (Munro, *in press*), several points regarding the little-known species *Chrysophrys cuvieri* Day came to notice. The more important matters concern its systematic position and nomenclature.

Very little regarding this species has been recorded in the literature, and it seems to have been accepted generally as belonging to the Sparinae section of the Family Sparidae. Smith (1938), when reviewing the genera and species of South African Sparidae, suggested that the correct generic designation of *cuvieri* would probably be *Acanthopagrus* Peters. He did not have the opportunity to examine actual specimens and his suggestion was merely surmise. *Chrysophrys cuvieri* was originally described by Day (1875) from India, the type locality being given as Mangalore on the Malabar coast (*vide* Fowler, 1933). Bleeker (1878) indicated that Day presented his specimen to the Leiden Museum. However, the Australian Museum, Sydney, has in its possession an old specimen (Reg. No. B 8225) from Madras. This specimen appears to have been obtained from Dr. Francis Day in 1885 and is labelled "Type." Whilst investigating the characters of *Acanthopagrus* with reference to Australian species, the present writer examined this example of *cuvieri* and found that it could not be referred to either of the sparid genera *Acanthopagrus* Peters or *Chrysophrys* Quoy and Gaimard.

The dentition of *cuvieri,* being essentially raptorial in character, serves to exclude this species from the family Sparidae, the representatives of which have sectorial and tritorial dentition. The combination of dentition and other primary characters, such as can be observed without dissection, place *cuvieri* in the Denticidae, a former subfamily of the Sparidae, now recognized as a distinct family (*vide* Smith, 1938). It is interesting to observe that Cuvier and Valenciennes (1830) remarked regarding their *Dentex hasta,* of which *C. cuvieri* Day is a synonym, "Nous, croyons donc devoir placer à la suite de nos dentés ce sparoide un peu anomal." They were more nearly correct in placing this form in *Dentex* Cuvier than Day was in placing it in *Chrysophris* Cuvier (= *Sparus* Linnaeus).

Although *cuvieri* is a fairly typical denticid fish, it possesses characters which exclude it from any of the existing genera of the Denticidae. Thus a new genus is herein proposed for its reception.

Day (1875), in naming this species *Chrysophrys cuvieri,* recognized that it was specifically identical with *Dentex hasta* Valenciennes (Cuvier and Valenciennes, 1830), also described from the Malabar coast. Day (p. 141) recorded that "it is identical with two specimens of *Dentex hasta,* C. & V. in the Paris Museum." When Day referred this species to *Chrysophrys* Cuvier (i.e., *Chrysophris;* not *Chrysophrys* Quoy and Gaimard), a substitute name for *Sparus* Linnaeus (*vide* Munro, *in press*), he realized that the specific name *hasta* Valenciennes (1830) was preoccupied in that genus by *Sparus hasta*

Bloch and Schneider (1801) from the Coromandel coast. He therefore substituted the specific name *cuvieri* to replace *hasta* Valenciennes. This action, however, is quite unnecessary, as *hasta* Bloch and Schneider, a synonym of *berda* Forskål, is now referred to the sparid genus *Acanthopagrus* Peters. Also *hasta* Valenciennes is herein shown to belong to a genus of the Denticidae and is thus far removed from *Sparus* Linnaeus. It is, therefore, correct to reinstate the older name, *hasta* Valenciennes, relegating *cuvieri* Day to synonymy.

***Sparidentex*, genus novum**

DIAGNOSIS.—Body elongate, not greatly elevated, laterally compressed. Head large, about equal to body depth. Eye small, diameter less than length of snout. Preorbital depth shallow, not greater than eye diameter. Mouth cleft horizontal and jaws approximately equal. Maxilla exposed posteriorly. Posterior nostril oval. Dentition entirely caniniform, no molars present. Anterior teeth fang-like; outer series of lateral teeth acute and compressed; inner series a villiform band. Gill-rakers lanceolate, fairly numerous. First and second spines of dorsal fin not abruptly shorter than the third spine; no filamentous dorsal spines. Preopercular flange scaleless. Interorbital also naked. Scales above and below the lateral line approximately equal in size. Soft dorsal and anal fins naked but with well-developed basal sheaths. Pectoral fin longer than head. Colour silvery to dusky, never rosy with bright-coloured markings.

ORTHOTYPE.—*Dentex hasta* Valenciennes (1830) = *Chrysophrys cuvieri* Day (1875). Genus monotypic.

AFFINITIES.—Of the more typical fishes of the Denticidae, Jordan and Thompson (1912) have separated the Indo-Pacific forms from those of the Atlantic. While the latter remain in *Dentex* Cuvier, 1815 (type, *Sparus dentex* Linnaeus), the former are transferred to *Taius* Jordan and Thompson, 1912 (type, *Chrysophrys tumifrons* Schlegel). Smith (1938) demonstrated that *Polysteganus* Klunzinger, 1870 (type, *Polysteganus caeruleopunctatus* Klunzinger) is synonymous with and has priority over *Taius*. These Indo-Pacific species have the scales on the head completely covering the interorbital region and the soft dorsal and anal fins are provided with well-developed, wide basal sheaths. The Atlantic forms have the fin sheaths vestigial and the head scales do not extend as far forward. *Sparidentex* differs from both *Dentex* and *Polysteganus* in having the interorbital region naked instead of scaled or partly scaled. It also differs from *Dentex*, but resembles *Polysteganus*, in possessing broad, well-developed, basal scalesheaths to the soft dorsal and anal fins. It resembles some species of *Dentex* (e.g. *filosus* Valenciennes and *gibbosus* Cocco) but differs from *Polysteganus* in having the preopercular flange entirely naked. The lack of scales on the interorbital region and preopercular flange cause *Sparidentex* to resemble certain genera of the Sparidae (e.g. *Acanthopagrus*) but this condition is not typical of either the Sparidae or Denticidae as a whole. Smith (1938) recognized three subgenera within the *Polysteganus* group, namely *Polysteganus* Klunzinger, *sensu stricto* (type, *P. caeruleopunctatus* Klunzinger), *Argyrozona* Smith (type, *Dentex argyrozona* Valenciennes) and *Axineceps* Smith (type, *Dentex*

praeorbitalis Günther). He is probably correct in assuming that they are distinct. The first of these appears to be strictly synonymous with *Taius* Jordan and Thompson, and also with *Allotaius* Whitley, 1937 (type, *Dentex spariformis* Ogilby). Regarding this group, *Sparidentex* comes closest to *Polysteganus, sensu stricto,* with respect to the possession of an oval, posterior nostril, a longer pectoral fin, equal jaws, subequal anterior canine teeth and a lower gill-raker count (7 + 9). *Sparidentex* resembles *Argyrozona* only in the elongate body shape. It diverges widely from *Axineceps* in that it possesses a narrow instead of an extremely broad preorbital, and in that the scales above the lateral line are equal to, instead of smaller than, those below. Of remaining denticid genera, it differs from *Cheimerus* Smith (type, *Dentex nufar* Valenciennes) in lacking the filamentous elongations of the dorsal fin spines. It differs from *Petrus* Smith (type, *Dentex rupestris* Valenciennes)

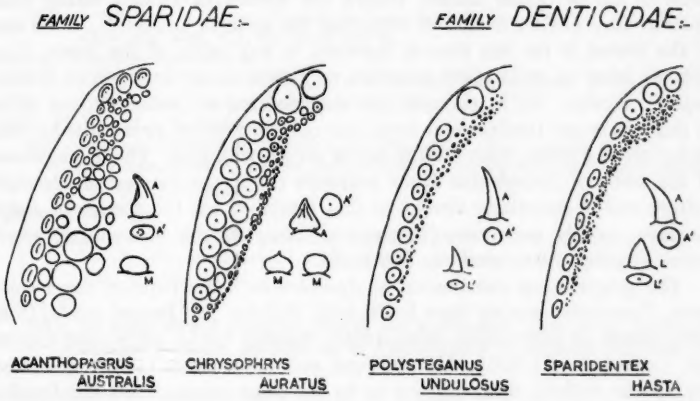

Fig. 1. Dentition of *Sparidentex,* showing similarity to *Polysteganus* and divergence from the sparid genera *Chrysophrys* and *Acanthopagrus.* Upper right-hand of jaws illustrated. *Polysteganus undulosus* after Barnard (1927: fig. 22), others based on actual specimens.

A—anterior conic canines; A'—horizontal sections of same; L—anterior acute canines; L'—horizontal sections of same; M—molariform teeth.

in those characters shared by *Petrus* and *Polysteganus* and in possessing wide, basal fin sheaths, the latter being vestigial in *Petrus*. *Sparidentex* also differs significantly from all other species of Denticidae in its colouration. The colour of *Sparidentex hasta* is reported to be silvery with black markings on the body and fins, some black cross banding anteriorly and with yellow fins. The colour is, in fact, not unlike that of some species of *Acanthopagrus,* notably *australis, berda* and *latus*. For this reason, it might be mistaken superficially as a species of the latter genus. All other species referred to genera of the family Denticidae appear to be reddish to silvery-pink in colour and often have darker shadings or bandings of other bright colours.

Day's (1875, 1889) description of the teeth of *cuvieri* (i.e., *hasta*) is inaccurate and misleading. He stated: ". . . along outer side of each jaw, the

last few teeth of which are small and with rounded crowns; inside these are two rounded rows of small molars in the lower and three in the upper jaw." In Day's example of *cuvieri* in the Australian Museum collection, the dentition is as illustrated (Fig. 1). In both upper and lower jaws are six conic, subequal incisors anteriorly. They are curved backwards and protrude slightly. They are succeeded on each side by a single row of flattened, acutely pointed, teeth. There is a narrow band of villiform teeth behind the anterior canines and along the inside of the lateral series. There are no molariform teeth as stated by Day. Blegvad and Løppenthin (1944) indicated the caniniform teeth in their examples of *cuvieri,* as opposed to the molariform teeth of *Sparus datnia,* i.e., *Acanthopagrus latus* (Houttuyn), and the sectorial teeth of *Crenidens crenidens,* both of the latter being sparid fishes. Valenciennes' description of the dentition of *hasta* is accurate and, because of its particular nature, placed the species in *Dentex* rather than *Sparus.* Day (1875) remarked, regarding the teeth of *cuvieri* ". . . the size of the molars is far less than is apparent in any other of the genus (i.e., *Sparus*) taken in India; they approach very close to the dentition of *Dentex nufar.*" Bleeker (1878) claimed that the dentition of *cuvieri* did not differ in disposition nor fundamental form, but only in relative strength from that of the genus *Sparus.* This view is not in accord with fact. The arrangement of the teeth of *Sparidentex hasta* conforms closely to the normal denticid pattern and is essentially similar to that described for the species of *Polysteganus,* namely *undulosus* (Regan), *caeruleopunctatus* Klunzinger, *spariformis* (Ogilby), and *tumifrons* (Schlegel).

The geographical distribution of *Sparidentex hasta* requires some comment. It is known mainly from India, both Malabar and Bengal coasts, from the accounts of Day (1875, 1888, 1889), Bleeker (1853, 1878) and Cuvier and Valenciennes (1830). Also Blegvad and Løppenthin (1944) described (as *Sparus cuvieri*) what appears to be the same species from the Iranian Gulf (Bushire Harbour). The true distribution appears to be restricted to India and Iran. It is replaced on the west (Red Sea), east (China-Japan), and south (Australia) respectively by species of *Polysteganus,* namely *caeruleopunctatus, tumifrons* and *spariformis.* Borodin (1932) recorded fish by this same name (*cuvieri*) from Brisbane (Queensland) and Noumea (New Caledonia). These latter records appear to be incorrect and based on misidentifications. The sparid fishes of Australia are exceptionally well-known to the present writer and it can be said with confidence that if *cuvieri* (i.e., *Sparidentex hasta*) occurs anywhere in eastern Australia, some specimens would have come to hand during the course of the extensive field work that has been carried out on Australian sparids during recent years (Munro, *in press*). Museums in Australia have no specimens from this coast that can be identified with *hasta.* It seems very probable that Borodin has misidentified a specimen of one of our Australian species of Sparidae or Denticidae. So-called squire or red bream, the young of the snapper, *Chrysophrys auratus* (Bloch and Schneider), might be so mistaken. There are also *Polysteganus spariformis* (Ogilby) of the family Denticidae, *Paradentex bitorquatus* (Cockerell) (= *Gymnocranius audleyi* Ogilby) and *Monotaxis affinis* Whitley of the family Pentapodidae, occurring in Queensland waters. Possibly a similar

error applies to Borodin's record from New Caledonia. It would be safer to exclude Borodin's records until they can be confirmed definitely. Accordingly, *Sparidentex hasta* should not be added to the Australian Check-List.

Most of the synonymy and references to *Sparidentex hasta* are given by Fowler (1933) under *Sparus cuvieri*. Excellent illustrations of the species are to be found in Day (1875: Pl. 34, fig. 3), Bleeker (1878: Pl. opp. p. 43), and Blegvad and Løppenthin (1944: Pl. 8, fig. 2).

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A Discussion of Abnormal Scale Patterns in Fishes, with Notice of Another Specimen with Reversed Scales

By GORDON GUNTER

INTRODUCTION

NORMAL scale patterns of fishes have been described often in texts and drawings. A detailed discussion of the geometry of symmetry of normal squamation in fishes has recently been given by Breder (1947).

Anomalies of squamation in local areas on fishes, especially on those which have suffered traumata, are known to every ichthyologist who has handled large numbers of specimens, but little has been written on the subject.

Reversed scales seem to be extremely rare. Four specimens have been reported in the literature. Taki (1938) described abnormal arrangement of scales and color bands on the posterior eyed-side of 2 soles, *Zebrias japonicus* (Bleeker), associated with interruption and deformation of the lateral line. Some scales were adverse, and the author said such scales had not been previously reported. Gunter (1941, 1945) reported 2 redfish, *Sciaenops ocellata* (Linnaeus), of the drum family (Sciaenidae), with reversed scales and stated that records of similar instances had not been found. Taki's paper was overlooked.

DESCRIPTION OF A FISH WITH REVERSED SCALES

A. *General Features.*—The specimen described here is another redfish, *S. ocellata,* 27.0 cm. in total length, caught on the Gulf beach of San José Island, at the mouth of Cedar Bayou Pass leading into Mesquite Bay, Aransas County, Texas, July, 1946, by Captain M. B. Mullinax of the Texas Game, Fish and Oyster Commission. The appearance was normal except for aberrant imbrication and shape of certain scales.

B. *Scale Pattern.*—Due to a series of mishaps all photographs and drawings were found to be inadequate after the specimen was ruined for such purposes by skinning and dissection, and nothing but the description can be presented. A similar specimen has been previously figured (Gunter, 1945). Below the lateral line, on the left side of the posterior belly and side above

the belly, there was a triangular patch of scales which extended forward on the belly and there turned upward, dorsally like a partially complete whorl, with part of the dorsal scales of this patch turned backwards. Ventrally there were about 5 rows of dorsally pointed scales on the lower belly, extending back to above the anal fin and turning more and more backward posteriorly.

Far back on the ventral side of the caudal peduncle another patch of scales pointed upward and fanned outward, forward and backwards, so that posteriorly the scales pointed in the usual manner towards the tail, while anteriorly they pointed forward, somewhat irregularly until they met the first patch described above. There were 3 rows of scales in this reverse pointing line, between the scales of the lateral line and the backward pointing scales just above the anal. The scales of the lateral line in this posterior region (one row only) pointed backwards.

Above the lateral line, from the caudal peduncle anteriorly, all scales pointed upward posteriorly and turned slowly forward until they met the normal backward-pointing scales under the sixth spine of the dorsal.

On the right side, beginning under the fourth ray of the soft dorsal, there were 3 irregular, continuous whorls of scales, with the centers of the whorls on the lateral line, forming an oblong patch of scales irregularly imbricated and pointing in all directions. Most of the center of this region was made up of stunted, irregularly shaped, very abnormal scales. The marginal area consisted of larger, more normal scales.

The two sides were not more or less symmetrical with respect to the scale pattern, as was the case with the two redfish with abnormal scale patterns previously reported (Gunter, 1941, 1945). On both sides the abnormal patterns were on the posterior half of the fish.

C. *Description of Scales.*—Checks in the circuli indicated that the fish was in the third year of its life. Striae numbered from 14 to 22 in number.

Redfish scales are finely ctenoid. Normal scales are shaped more or less like truncate lozenges with the free edge rounded and the inserted edge practically straight. They are broader than long.

Many of the larger reversed scales were more or less normal in appearance, but they were not so wide as the normal ones and some of them were more or less oval without the truncate inserted edge. Some of the abnormal scales had the ctenoid edge twisted and undeveloped on one side, while the striated or inserted edge was normal, and therefore projected out to one side like a wing.

Some of the reversed lateral line scales, which occurred only on the right side, were irregularly reniform in shape, with ctenoid edges widely separated by a deep notch in front of the tubule opening. The striae were few and the cross-striated area was small. The tubules on lateral line scales were essentially tri-pronged, with some variation.

In addition to the large scales, small, very aberrant scales were present in the whorls, especially near the center. They were of various rounded, notched and irregular shapes. Scales at the edge of the abnormal areas were sometimes directly opposed or facing normally directed scales. Therefore, it can be concluded that the scales do not necessarily influence or determine the

position of adjacent scales. Single adverse scales among normal ones were not present; instead such scales were in areas or patches, similar to Taki's (*op.cit.*) findings on *Zebrias*.

Histological sections of the skin yielded no information of any importance. Sections with scales *in situ* were not made. The specimen had been preserved in formalin for a year and was not good histological material.

D. *Myotomes*.—The myotomes or muscle segments of the specimens were normal in all grosser anatomical respects. The fish differed from its fellows in no visible internal aspect.

Discussion

The specimen described here and the two previously reported by the author all belong to the same species, *S. ocellata*, and were all taken within 40 miles of one another on the Texas coast. The scarcity of such specimens, the appearance of 3 of the same species from the same area (2 apparently from the same small bay), strengthen the probability suggested by Gunter (1945) that "there is some hereditary condition in certain redfish of the Redfish Bay area that produces the aberrant scale pattern." The hereditary theory is more probable than an explanation based on the assumption of an environmental influence because the 2 specimens reported before were more or less bilaterally symmetrical with respect to the abnormal scale pattern. An environmental influence which would give a bilaterally symmetrical result is not very probable.

Taki (1938) and Gunter (1941, 1945) found certain facts and drew certain conclusions which should be summarized. Taki came to the conclusion that reverse scales on the sedentary *Zebrias japonicus* "give no particular disadvantage to the activity of the animal." Gunter (1941) noted no frizzling or projection of the scales and stated that, because of the mucous covering, the fish probably swam as easily as its congeners. However, it was noted that the fish then under consideration, due to its small size, would not have been taken in a trammel net had it not had reversed scales. Redfish are given to feeding among the grass of shallow waters and it is quite likely that specimens with reversed scales are somewhat handicapped by the abnormality. It was stated that the rarity of reversed scales might indicate an anti-survival effect.

Taki noted that adverse scales were confined to the posterior part of the eye-side of the body. The 2 redfish previously described by the writer had essentially similar patterns on both sides and the reversed scales were mostly on the last half of the body. The specimen described here is asymmetrical with respect to abnormal scale patterns on the two sides, but the abnormal areas were on the posterior half of the body.

The change in scale pattern in the fishes was accompanied by production of abnormal scales (Taki, 1938; and Gunter, 1941). Gunter noted particularly that some scales were minute.

Gunter (1941) stated that, since scales are formed after the larval redfish are in the swimming stage, and yet some of them may be reversed, it follows that the direction of scale imbrication is not determined, not altogether at least, by the stimulus of water flow past the body. He also con-

cluded, similarly to Taki, that the condition causing reversed scales "must have been present when the dermis was first formed in the embryo."

Taki found in the two soles that the scale abnormalities were on the eyeside and combined with anomaly ("injury") of the lateral line. The abnormally arranged scales were found in groups and in no instance was a single reverse scale found among normally directed scales. In one specimen radial arrangement of the scales was noted. Color bands were shifted in such a way that they lay perpendicular to the direction of the scales. The scales were abnormal in appearance, being slightly wider and more bluntly pointed than the others. Taki stated that it was impossible to explain the real origin of abnormally directed scales, but that the disturbance in scale imbrication occurred very early in the embryonic stage. Since color bands were found to be abnormal without abnormal squamation, it was concluded that epidermal disturbance did not influence dermal structure, but that dermal disturbance brings about epidermal abnormality. Taki noted that direction of the scales was analogous to that of a current of liquid, which led him to suggest the existence of some "physico-chemical current at the formation of scales in the embryonic stage."

Theoretical Considerations

It has long been known (Ryder, 1891, 1892; and Hase, 1907) that there is a connection between squamation of fishes and the underlying myotomes. Breder (1947) has shown that the squamation of fishes is an example of serial symmetry, in that the transverse scale lines follow a geodesic curve around the fish. He discussed the relationship between the vertebral column, muscle segments, and scale patterns, saying, "The serially symmetrical vertebral column attached by the complicated muscle mass to the bending surface and its appropriate fragmentation into a basically rhombic pattern of symmetry of surface present a whole that is at once rigid and flexible in a manner that would be hard to conceive of by any other mechanically possible arrangement, providing a beautifully streamlined form which at the same time is the propulsive mechanism."

The conclusions of Breder and his predecessors (cited above) concerning the relations of vertebrae, myotomes and scales is strongly supported by Gunter's (1943) description of a "dumpy" croaker, *Micropogon undulatus* (Linnaeus), another member of the family Sciaenidae. This specimen was essentially telescoped. The vertebrae were normal in number, but were much shorter than normal. In consequence, the myotomes, fin rays, scales, and, of additional significance, the color pattern, were jammed or telescoped together. Their number and nature were not otherwise changed.

The connection between the vertebrae, myotomes and scale pattern seems to be a strong one and disturbances in the vertebral pattern would probably always be associated with changes in the myotomic and scale patterns. There seems to be some reason for suspecting the existence of a direction of influence from vertebra to myotome to scale pattern to color pattern, or from within outward, as with Taki's dermis-epidermis abnormalities, which may not be so strong in the reverse direction. Agreeing with this, the myotomes of the present specimen were perfectly normal while the scale pattern was very

abnormal and in large areas could not be related to the myotomes. Taki's discovery that color bands of *Zebrias japonicus* were disturbed without disturbance of the underlying scales, but that abnormal scale patterns were accompanied by abnormal color bands, supports the same view.

In summary, the observations of Ryder (1891, 1892), Hase (1907), Gunter (1943), and Breder (1947) have shown that there is an essential connection or relation between the symmetry or pattern of the vertebrae, myotomes, and scales of fishes. Additional observations of Taki (1938) and Gunter (1943) show that this relation extends from the dermis (scales) to the epidermis (color pattern). Conversely, there are no observations indicating that disturbances of surface layers bring about changes in the deeper layers. Possibly the pattern of symmetry of a fish's bones, musculature, and skin elements is more strongly connected than has hitherto been supposed from the inside to the outside, the central influent of anatomical pattern symmetry being the vertebral column. This would amount to a sort of gross anatomical or mechanical polarity from the interior (vertebral column) of the fish's body to the skin, and structural rather than "physiological" in the ordinary sense of that term. This is a purely theoretical consideration, but it can presumably be verified or not by observation or experimentation and the question is raised so that future workers might hold it in mind.

Taki said that at the zone of contact between the adverse and ordinary scales "there are found a number of cases in which several scales are arranged as in a whirl-pool. This state of scale arrangements analogous to a liquid current suggests the existence of a physico-chemical current in the colloidal substance in the formation of the structure of integument." These whirl-pools of Taki are strictly similar to the whorls of scales described in the present fish. The slowly changing direction of certain patches of scales, although not strictly whorls, are also reminiscent of currents of liquid. More particularly they appear like fields of forces and it is most reasonable to suspect that they were brought about by the operation of some such field or "physico-chemical current."

Much evidence for the existence of electric correlation potentials, arising from electric polarities of structurally polar cells and the resulting bioelectric fields, has recently been presented by Lund and Collaborators (1947). This electrical field acts instantaneously over a distance and is the only known integrating mechanism which could function primitively in morphogenesis, as a directive force or pattern in laying down new structures, in the absence of nervous systems and hormones. Probably it functions as the chief correlative mechanism in all processes of morphogenesis and growth. The similarity of abnormal scale patterns of the fishes discussed here to fields of force lead to the suggestion that they possibly resulted from some unknown anomaly of the bioelectric fields on the surface of the developing embryos. This is another theoretical consideration which might be held in mind by future workers.

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Notes on Some Brazilian Anchovies (Family Engraulidae) with Descriptions of Four New Species

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THIS contribution to the knowledge of the Engraulidae is based principally on specimens collected by the junior author on the coast of southern Brazil. That section of the coast is rich in manjubas (anchovies), and it may be expected to yield more new species. Some additional information on several known species is included. Also, notes on one species, *Anchoviella iheringi*, from northern Brazil, not included in the senior author's review (1943), have been added.[1]

Engraulis anchoita Hubbs and Marini

Engraulis anchoita Hubbs and Marini, in Marini, 1935: 448, fig. 2 (Mar del Plata, Argentina); Hildebrand, 1943: 18, fig. 4; Fowler, 1943: 311, fig. 1 (Punta Jose, Maldonado, Uruguay).

[1] A few corrections in "A Review of the American Anchovies (Family Engraulidae)" (Hildebrand, 1943) seem in order. In the key to the genera in the last line of section "bb" (page 12), anal should be substituted for "dorsal." In the key to the species of *Anchovia* (page 21) in the third line of section "a," substitute anal for "dorsal," and delete the words "vertical from." Similarly, substitute anal for "dorsal" and delete "vertical from" in the fourth line in section "aa" of the same key.—S.F.H.

This species, heretofore known only from Mar del Plata, Argentina, and from Maldonado, Uruguay, is represented in the present collection by 15 specimens, taken at Formosa, Pontal da Cruz, and Ponta Azeda, all on São Sebastião Island, in the State of São Paulo. The specimens are all small, ranging from 43 to 57 mm. in standard length and from about 52 to 67 mm. (caudal fins damaged) in total length. These specimens agree fairly well with a paratype at hand and with the description offered by Hildebrand (1943: 18), except for the number of dorsal rays, given as 13 or 14. The enumerations seem to have been based on the divided rays, as the paratype at hand has a total of 15 rays, which is in agreement with some of the specimens in the present collection. It should be pointed out also that the scales of the small patch shown in Hildebrand's figure are much too small.

The proportions and enumerations that follow are based on 6 specimens from São Sebastião Island, ranging from 43 to 57 mm. in standard length: Head 3.3 to 3.7 in standard length; depth 5.5 to 7.0; postorbital part of head 6.9 to 7.4; maxillary 5.3 to 5.5; mandible 4.9 to 5.5; anal base 4.9 to 5.7; pectoral fin 6.1 to 6.9. Snout 5.3 to 6.1 in head, eye 3.6 to 4.1; maxillary 1.45 to 1.55; mandible 1.45 to 1.5; ventral fin 2.4 to 3.0; pectoral fin 1.8 to 1.95. D. 15 or 16; A. 20 to 23; P. 15 or 16; scales mostly lost, about 39 to 45 pockets; gill rakers 27 to 30 + 38 to 45; vertebrae 46 (enumerated in one specimen).

The small specimens at hand have a bright silvery lateral band, which is notably broader in the larger than in the smaller individuals of these lots.

Known from São Sebastião Island, Brazil; Maldonado, Uruguay; and Mar del Plata, Argentina.

Anchoa tricolor (Agassiz)

Engraulis tricolor Agassiz, in Spix and Agassiz, 1829: 51, pl. 23, fig. 1 (Bahia, Brazil).
Anchoa tricolor Hildebrand, 1943: 74, fig. 30.

This species, which was long confused with *A. hepsetus*, has several synonyms, as shown by Hildebrand (1943: 74). It is represented in the present collection by 3 specimens, respectively, 100, 100, and 105 mm. in total and 81, 82, and 86 mm. in standard length, from the Rio de Janeiro market. It is distinguishable from *A. hepsetus* by the shorter maxillary, which reaches only to, or slightly beyond, the joint of the mandible, and by its round upper free margin. In *A. hepsetus* the maxillary reaches well beyond the joint of the mandible and nearly or quite to the margin of the opercle, and its upper free margin is straight. *A. tricolor* differs further in having more gill rakers, the usual formula being 18 to 22 + 24 to 28, whereas that of *A. hepsetus* is 15 to 20 + 18 to 24. Although *A. hepsetus* occurs in southern Brazil and as far south as Uruguay (and northward to Nova Scotia), it is not included in the collections on which this paper is based.

The proportions and enumerations that follow are based on the 3 specimens listed in the preceding paragraph. Head 3.8, 3.9, 4.1 in standard length; depth 4.75, 5.0, 5.1; postorbital part of head 7.8, 8.1, 8.2; maxillary 5.2, 5.4, 5.45; mandible 5.6, 5.75, 5.8; anal base 5.4, 5.4, 5.9; pectoral fin 6.75, 6.8, 7.1. Snout 5.4, 5.5, 5.55 in head; eye 3.3, 3.5, 3.6; maxillary 5.2, 5.4,

5.45; mandible 5.6, 5.75, 5.8; ventral fin 6.75, 6.8, 7.1; pectoral fin 1.7, 1.75, 1.8. D. 14, 15, 15; A. 19, 21, 21; P. 13, 14, 14; scales lost, about 41 pockets; gill rakers 19 + 25, 20 + 25, 21 + 26; vertebrae 43 (enumerated in one specimen).

Known from the Mar del Plata, Argentina, to Brazil and probably northward to the Gulf of Venezuela.

Anchoa marinii Hildebrand

Anchovia platana Marini, 1935: 446 (*nomen nudum*),
Anchoa marinii Hildebrand, 1943: 99, fig. 42 (Montevideo, Uruguay, and Mar del Plata, Argentina).

There are 4 specimens, 100 to 105 mm. in total and 80 to 88 mm. in standard length, in the present collection. Three of these are from Santana, Rio de Janeiro, and one is from a market in Rio de Janeiro. This species was reported heretofore only from Montevideo, Uruguay, and Mar del Plata, Argentina. The specimens were compared with the type and a paratype from Montevideo, with which they agree quite well.

The proportions and enumerations that follow are based on the 4 specimens listed in the preceding paragraph. Head 3.4 to 3.5 in standard length; depth 4.1 to 4.5; postorbital part of head 5.9 to 6.3; maxillary 4.3 to 4.6; mandible 4.9 to 5.1; anal base 3.7 to 4.0; pectoral fin 5.2 to 5.8. Snout 5.1 to 5.45 in head; eye 3.85 to 4.4; maxillary 1.3; mandible 1.45; ventral fin 2.65 to 3.3; pectoral fin 1.5 to 1.8. D. 14 or 15; A. 24 to 26; P. 13 or 14; scales lost, about 40 to 42 pockets; gill rakers 20 or 21 + 23 or 24; vertebrae 42 (enumerated in one specimen).

A silvery lateral band, which is well defined in 2 specimens, ill-defined in another one, and abruptly broadened under the base of the dorsal in the fourth, is present. The only other color marking is a dusky area at the nape, composed of dusky punctulations, which extend along the back and on the caudal fin.

Known from Rio de Janeiro, Brazil; Montevideo, Uruguay; and Mar del Plata, Argentina.

Anchoa januaria (Steindachner)

Engraulis januaria Steindachner, 1879: 58 (Harbor of Rio de Janeiro, Brazil).
?Stolephorus maryuba Ribeiro, 1908: no page, no fig. (Xiririca, Rio Ribeira, State of São Paulo, Brazil).
Anchoa januaria Hildebrand, 1943: 81, fig. 34.

This anchovy is represented in the present collections by 18 specimens, some of them not in good condition. These specimens, which range from 77 to 90 mm. in total and 62 to 73 mm. in standard length, were collected in São Paulo City market, and in the Rio Casqueiro, São Vicente Island, State of São Paulo. The specimens in general agree fairly well with the description offered by Hildebrand (1943: 81). However, the number of gill rakers on the lower limb of the first arch seem to be more numerous. This may not be significant, as the rakers are so fine and close-set that they are difficult to enumerate accurately. Unfortunately, it is not possible to recheck the earlier

enumerations as the specimens on which they were based are not at hand now. The scales are well described in the original account. As indicated in that description, they are fairly adherent, and are characterized by numerous vertical ridges. The ridges are not equally numerous, however, in all examples. This is true even if the examinations are based on scales removed from the same section of the body of different specimens.

This species is characterized further by the rather deep, strongly compressed body, by the numerous gill rakers, and the rather anterior position of the anal fin, which begins under or slightly posterior to the middle of the base of dorsal. The proportions and enumerations that follow are based on 16 of the specimens listed in the preceding paragraph. Head 4.15 to 4.4 in standard length; depth 4.25 to 5.0; postorbital part of head 8.5 to 9.3; maxillary 5.5 to 6.1; mandible 6.25 to 6.5; anal base 4.3 to 4.75; pectoral 5.9 to 6.5. Snout 4.95 to 5.55 in head; eye 3.1 to 3.65; maxillary 1.3 to 1.35; mandible 1.45 to 1.5; ventral fin 2.25 to 3.0; pectoral fin 1.35 to 1.5. D. 14 or 15; A. 21 to 24; P. 12; scales mostly adherent, about 36 to 38; gill rakers 22 or 23 + 27 to 32; vertebrae 40 or 41 (enumerated in 4 specimens).

Alipio de Miranda Ribeiro (1908) described an anchovy, *Stolephorus maryuba* from the Rio Ribeira, taken at Xiririca, in the State of São Paulo, which is not included in Hildebrand's review (1943). Ribeiro, unfortunately, did not state the number of gili rakers, a most important character. As far as his description goes, it seems to agree fairly well with *A. januaria*. Accordingly, we have placed Ribeiro's name in the synonymy of this species, with a question, however, as it is impossible to determine from the description with certainty whether *maryuba* is identical with *januaria*.

Rodolpho von Ihering (1930: 232), in a brief account, stated that the original specific name *maryuba* evidently was a typographical error, *manjuba*, a widely used common name for anchovies in Brazil, having been intended.

Known from the Gulf of Venezuela southward to São Paulo, Brazil.

Anchoa ***nasuta,*** n. sp.

Fig. 1

Head 3.5 to 3.8 (3.7) in standard length; depth 5.1 to 6.0 (5.4). D. 13 or 14 (13); A. 21 or 22 (21); P. 12 to 14 (13); scales mostly lost, about 39 to 45 (42) pockets; vertebrae 42 (enumerated in one paratype).

Body quite slender, moderately compressed, its greatest thickness somewhat exceeding half the depth; the dorsal and ventral profiles about evenly convex; head moderately small and low, its depth at joint of mandible slightly exceeding length of postorbital part of head; snout long, extending nearly its full length beyond tip of mandible, 4.3 to 5.0 (4.8) in head; eye small, 4.0 to 4.7 (4.7) in head, 2.1 to 2.6 (2.6) in postorbital part of head; maxillary rather narrow, reaching beyond joint of mandible, but not to margin of opercle, rather bluntly pointed, its upper free margin gently convex, 1.25 to 1.35 (1.25) in head, 4.5 to 4.8 (4.8) in standard length; cheek long and narrow, only a little shorter than snout and eye, its posterior angle acute, about 25°; postorbital part of head long, 6.25 to 6.8 (6.7) in standard length; mandible 5.2 to 5.5 (5.4); teeth in the jaws all minute; gill rakers at angle of

first arch about two-thirds length of eye, with prominent serrations along inner edge, 20 to 23 (21) on upper limb and 24 to 27 (24) on the lower one of first arch; scales very thin, those from middle of side below dorsal fin with a few feebly developed vertical ridges; dorsal fin elevated anteriorly, the longest rays failing notably to reach tip of last one if deflexed, its origin slightly nearer base of caudal than tip of snout; anal fin rather short, its origin under or just behind base of last ray of dorsal, its base 5.1 to 5.5 (5.4) in standard length; ventral fin fairly long, reaching a little more than half way to origin of anal, inserted somewhat nearer base of pectoral than origin of anal, and fully an eye's diameter in advance of vertical from origin of dorsal, 2.6 to 3.1 (2.6) in head; pectoral fin rather short, failing to reach base of ventral by a little less than diameter of eye, 1.9 to 2.1 (2.0) in head, 7.0 to 7.8 (7.6) in standard length; axillary scale of pectoral reaching to beginning of distal third of pectoral, 3.2 to 3.3 (3.2) in head.

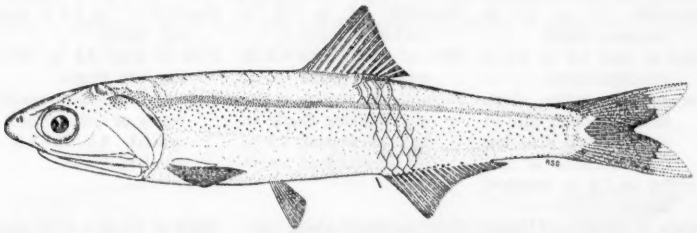

Fig. 1. *Anchoa nasuta.* From the holotype (USNM No. 143903), 54 mm. in standard length. (Drawing by Mrs. Ann S. Green.)

Color in alcohol pale straw; sides of head bright silvery; lateral band bright silvery, about as broad as eye above base of anal and bordered above with a dark streak composed of a concentration of dusky dots; upper surface of head and back with dusty dots, much more numerous in some specimens than in others, extending on dorsal and caudal fins; base of anal generally with a row of dark dots on each side, continued as a single median series of dots on the peduncle behind the fin; other fins plain.

This species is represented in the collection by 6 specimens, about 58 to 83 mm. (caudal fins broken) in total and 47 to 67 mm. in standard length. Five of these specimens were taken at São Sebastião, São Sebastião Island, Brazil, and one from Victoria, State of Espirito Santo. A specimen about 65 mm. in total and 54 mm. in standard length (USNM No. 143903) from São Sebastião has been designated the type. The enumerations and proportions based on the type are enclosed in parenthesis, following the range in each instance, in the foregoing description.

This form is closely related to *A. naso* and *A. nasus,* two very closely related species from the Pacific coast of South America. These species are all characterized by the long snout, which extends nearly its full length beyond the tip of the mandible. The close relationship of the three species is shown in large part in the parallel comparison, which follows. Inasmuch as

the enumerations and proportions of *naso* and *nasus* are based on 25 specimens and some of them on many more, they should portray the range rather accurately. The material of *nasuta* at hand, of course, is inadequate for such a determination, but if the range falls outside of those for the other two species the deviation should be significant.

nasuta, n. sp.	*naso*	*nasus*
Dorsal rays 13 or 14	Dorsal rays 14 or 15	Dorsal rays 15 or 16
Anal rays 21 or 22	Anal rays 22 to 27	Anal rays 21 to 27
Head 3.5 to 3.8 in standard length	Head 3.1 to 3.4 in standard length	Head 3.3 to 3.9 in standard length
Depth 5.1 to 6.0 in standard length	Depth 4.2 to 5.4 in standard length	Depth 3.9 to 4.6 in standard length
Snout 4.3 to 5.0 in head	Snout 4.9 to 6.0 in head	Snout 5.0 to 5.7 in head
Postorbital part of head 6.25 to 6.8 in standard length	Postorbital part of head 5.7 to 6.4 in standard length	Postorbital part of head 5.5 to 7.5 in standard length
Mandible 5.2 to 5.5 in standard length	Mandible 4.6 to 5.2 in standard length	Mandible 4.7 to 5.6 in standard length
Base of anal 5.1 to 5.5 in standard length	Base of anal 3.8 to 4.8 in standard length	Base of anal 4.2 to 4.6 in standard length
Pectoral fin rather short, failing to reach base of ventral by a little less than diameter of eye, 7.0 to 7.8 in standard length	Pectoral fin longer, generally reaching nearly to base of ventral, 5.7 to 6.4 in standard length	Pectoral fin longer, reaching nearly or quite to base of ventral, 5.3 to 6.3 in standard length
Origin of dorsal only slightly nearer base of caudal than tip of snout	Origin of dorsal about equidistant from base of caudal and anterior margin of eye	Origin of dorsal a little nearer posterior margin of eye than base of caudal
Origin of anal under or just behind base of last ray of dorsal	Origin of anal generally somewhat posterior to middle of base of dorsal	Origin of anal under or just behind base of last ray of dorsal

The name, *nasuta*, was suggested by the long snout.

Known only from the type material, from São Sebastião, São Sebastião Island, and from Victoria, State of Espirito Santo, Brazil.

Anchoa ubatubae, n. sp.

Fig. 2

Head (4.15), 4.2, 4.25 in standard length; depth (4.4), 4.6, 4.7. D. (16), 16, 16; A. (24), 24, 26; P. 14, 14 (15); scales nearly all lost, about 40, 41 (41) pockets; vertebrae 42 (enumerated in 1 paratype).

Body deep, strongly compressed, its greatest thickness notably less than depth of caudal peduncle, about two and a half times in its depth; ventral profile much more strongly convex than the dorsal; head fairly short and deep, its depth at joint of mandible about equal to postorbital part of head and half the eye; snout very short, compressed, scarcely pointed, projecting about half its length beyond tip of mandible, 6.4, 6.5 (7.2) in head; eye quite small, 3.65, 3.9 (4.0) in head, 2.0, 2.05 (2.2) in postorbital part of head; maxillary pointed, reaching little beyond joint of mandible (1.3), 1.4, 1.6 in head, (5.4), 6.0, 6.7 in standard length; cheek short and broad, a little longer than eye,

its posterior angle broad, about 50°; postorbital part of head moderately long in comparison with rest of head, (7.7), 7.8, 8.0 in standard length; mandible 5.85 (5.9), 6.25; teeth in the jaws all minute; gill rakers at angle of first arch scarcely as long as eye, with definite serrations along inner edge, 14 (14), 15 on upper limb and 20, 20 (21) on lower limb of first arch; dorsal fin with a broad sheath of scales at base, moderately elevated anteriorly, the longest rays not reaching tip of last one if deflexed, its origin about equidistant from middle of eye and base of caudal; anal moderate, with a broad sheath of scales at base, its origin a little behind that of dorsal, its base (3.6), 3.65, 3.65 in standard length; ventral fins very close together with a broad scaly sheath covering the inner rays of each fin, the fins reaching notably more than half way to origin of anal, inserted slightly nearer origin of anal than base of pectoral, 2.0, 2.2 (2.35) in head; pectoral long, reaching to or a little beyond base of ventral, inserted about equidistant from middle of eye and base of ventral, 1.15 (1.2), 1.2 in head, 4.9 (4.9), 5.1 in standard length; axillary scale of pectoral rather long and narrow, reaching about to beginning of distal third of pectoral (1.85), 1.9, 2.0 in head.

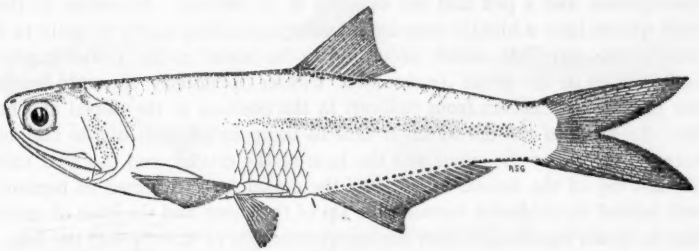

Fig. 2. ***Anchoa ubatubae.*** **From the holotype (USNM No. 143908), 54 mm. in standard length. (Drawing by Mrs. Ann S. Green.)**

Color pale, no definite lateral band, though with an indication of one probably faded in preservative (which is not unusual in anchovies preserved in strong formalin), underlaid with dusky points forming a dark band on posterior two-thirds or so of body; dark dots extending from vertical margin of snout to base of upper lobe of caudal fin, forming a dark band in front of the dorsal fin and principally in two lines behind the dorsal, extending also on the caudal fin, being most numerous on the outer rays, the margin of this fin dusky; anal fin with a row of black spots along the base, the fin otherwise plain; ventral and pectoral fins plain, unmarked.

This anchovy is represented in the collection by 3 specimens, respectively 57, 65, and 70 mm. in total and 47, 51, and 54 mm. in standard length. The largest one (USNM No. 143908) has been designated the type. The specimens were collected at Ubatuba, in the northern part of the State of São Paulo. The enumerations and proportions based on the type are enclosed in parenthesis in the foregoing description.

This species seems quite distinctive. It has the rather long pointed maxil-

lary of the members of the genus *Anchoa,* but the short blunt snout of those of the subgenus *Amplova.* Its snout differs from that of the species of *Amplova,* however, in being compressed instead of rounded, hence it is not exactly "pig-like," as generally stated for the members of this family. Because of its rather long pointed maxillary it belongs to *Anchoa* rather than *Amplova. A. ubatubae* is characterized further by its strongly compressed body; the small eye; few gill rakers; the anterior position of the anal fin with reference to the dorsal fin; and the long pectoral fin, which reaches beyond the base of the ventral.

The species is named for the type locality, Ubatuba, in the State of São Paulo.

Known only from Ubatuba, State of São Paulo, Brazil.

Anchoviella iheringi Fowler

Anchoviella iheringi Fowler, 1941: 124, fig. 2 (Rio Jaguaribe, State of Ceará, Brazil.)

This apparently valid species was not included in Hildebrand's review (1943). It is related to *Engraulis vaillanti* Steindachner. As no specimens of either species are available for examination the authors must rely wholly on descriptions, and a pen and ink drawing of *A. iheringi.* According to these both species have a bluntly rounded maxillary, reaching nearly or quite to the joint of the mandible, which, according to the senior author's review, places both species in the genus *Anchoviella.* Fowler apparently correctly pointed out that *iheringi* differs from *vaillanti* in the position of the dorsal and anal fins. In *vaillanti* the dorsal fin is said to begin in advance of the midpoint between the tip of the snout and the base of the caudal, and the anal under the last ray of the dorsal. In *iheringi* the dorsal fin is depicted as beginning well behind the midpoint between the tip of the snout and the base of caudal, that is, about equidistant from the anterior margin of the eye and the base of the caudal, and the anal fin is shown as beginning slightly in advance of the vertical from the middle of the base of the dorsal.

The following proportions and enumerations are from Fowler's description of *A. iheringi.* Head 3.8 to 4.2 in standard length; depth 4.75 to 5.0. Snout 5.0 to 5.2 in head; eye 3.0 to 3.2; maxillary 1.2 to 1.25; ventral fin 2.33 to 2.5; pectoral 1.5. D. 15; A. 24 to 26; P. 13; scales (pockets) 33; gill rakers 14 + 19.

Known only from the type material consisting of 3 specimens, 80, 98, and 100 mm. long, from the Rio Jaguaribe, State of Ceará, Brazil.

Anchoviella ***victoriae,*** n. sp.

Fig. 3

Head 4.3 to 4.5 (4.3) in standard length; depth 5.5 to 5.95 (5.85). D. 15 or 16 (15); A. 16 or 17 (16); P. 14 to 16 (15); scales lost, about 39 to 41 (39) pockets; vertebrae 42 (enumerated in one paratype).

Body moderately slender, fairly robust, its greatest thickness fully equal to half its greatest depth; ventral profile somewhat more strongly convex than the dorsal; head rather large and deep, its depth at joint of mandible nearly equal to its postorbital length and half the eye; snout quite blunt, not-

ably shorter than eye, extending only about a fourth of its length beyond tip of mandible, 4.65 to 5.25 (5.05) in head; eye rather large, 3.35 to 3.6 (3.6) in head, 1.7 to 1.85 (1.85) in postorbital part of head; maxillary somewhat expanded distally, broadly rounded, failing to reach joint of mandible by a space scarcely as great as diameter of pupil, 1.55 to 1.65 (1.65) in head, 6.7 to 7.2 (7.2) in standard length; cheek a little shorter than eye, its posterior angle broad, about 60°; postorbital part of head short, 8.5 to 8.7 (8.55) in standard length; mandible 6.4 to 6.7 (6.7); teeth in the jaws minute, gill rakers at angle of first arch about two-thirds length of eye, with moderately strong serrations along inner edge, 21 to 23 (21) on upper limb and 29 to 33 (33) on the lower one of first arch; dorsal fin with concave margin, moderately elevated anteriorly, the longest rays not quite reaching the tip of the last one if deflexed, its origin a little nearer base of caudal than tip of snout; anal fin short, moderately elevated anteriorly, its origin well behind vertical from base of last ray of dorsal, and a little in advance of tip of last ray if deflexed, its base 7.5 to 8.5 (7.8) in standard length; ventral fin rather small,

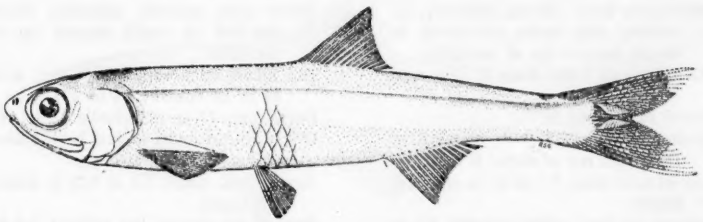

Fig. 3. *Anchoviella victoriae*. From the holotype (USNM No. 143901), 94 mm. in standard length. (Drawing by Mrs. Ann S. Green.)

inserted fully an eye's diameter in advance of vertical from origin of dorsal, and a little nearer base of pectoral than origin of anal, reaching much less than half way to beginning of the anal, and about to vertical from origin of dorsal, 2.1 to 2.25 (2.25) in head; pectoral fin moderately long, fairly pointed, failing to reach ventral by about diameter of eye, inserted about equidistant from tip of mandible and base of ventral, 1.25 to 1.4 (1.3) in head, 5.6 to 6.0 (5.9) in standard length; axillary scale of pectoral long and slender, failing to reach tip of fin by about diameter of pupil; 1.45 to 1.6 (1.4) in head.

Color in alcohol, plain straw; side of head bright silvery; a broad bright silvery lateral band, about as broad as eye above base of anal, with a dark border above; a blackish area at nape; median line of back with dark dots arranged more or less definitely in two rows, especially behind the dorsal fin; base of upper lobe of caudal fin with a dark area extending forward on caudal peduncle; caudal fin with scattered dark points, most numerous on outer rays; a few dark dots on anterior rays of dorsal; other fins plain, unmarked.

This species is represented in the collection by 4 specimens, taken at Victoria, State of Espirito Santo, Brazil, which range from about 105 to 115 mm.

(caudal fins damaged) in total and 87 to 94 mm. in standard length. The largest one (USNM No. 143901) has been designated the type. The enumerations and proportions based on the type are in parenthesis following the range in each instance in the foregoing description.

This apparently undescribed species belongs to that group of the genus with rather long maxillaries, which reach far beyond the posterior rim of the eye but not to the joint of the mandible, and in which the origin of the anal is under or well behind the base of the last ray of the dorsal. Within this group it is rather closely related to *A. eurystole,* which ranges from Woods Hole, Massachusetts, to or beyond Beaufort, North Carolina; *A. estauquae,* from the Gulf of Venezuela; and especially close to *A. perfasciata,* which ranges from Florida throughout the West Indies. Its close relationship with *perfasciata,* seemingly, can be shown best in a parallel comparison of the two species.

A. victoriae, n. sp.	*A. perfasciata*
Head 4.3 to 4.5 in standard length	Head 3.9 to 4.3 in standard length
Postorbital part of head 8.5 to 8.7 in standard length	Postorbital part of head 7.5 to 8.5 in standard length
Snout quite blunt (for an anchovy), extending only about one-fourth its length beyond tip of mandible	Snout more pointed, extending about one-half its length beyond tip of mandible
Gill rakers on lower limb of first arch 29 to 33	Gill rakers on lower limb of first arch 24 to 28 (usually 25 to 27)
Dorsal rays 15 or 16	Dorsal rays 12 to 15 (usually 13 or 14)
Origin of anal slightly in advance of tip of last ray of dorsal if deflexed	Origin of anal under or just behind base of last ray of dorsal
Base of anal short, 7.5 to 8.5 in standard length	Base of anal longer, 6.5 to 7.25 in standard length
Pectoral fin long, rather pointed, 5.6 to 6.0 in standard length	Pectoral fin shorter, less pointed, 7.0 to 8.2 in standard length

The species is named after the locality, Victoria, in the State of Espirito Santo, Brazil, where the type material was collected.

Known only from the type locality.

Anchoviella nitida, n. sp.

Fig. 4

Head 4.0, 4.1 (4.3) in standard length; depth 4.3, 4.8 (4.7). D. 14, 15 (15); A. 22, 23 (22); P. 14, 14 (15); scales lost, about 38, 40 (39) pockets; vertebrae 40 (enumerated in one paratype).

Body moderately deep and compressed, its greatest thickness slightly exceeding depth of caudal peduncle; ventral and dorsal profiles about evenly convex; head rather large and deep, its depth at joint of mandible about equal to its postorbital length and three-fourths the eye; snout short, only about half as long as eye, extending a little less than half its length beyond tip of mandible, 6.0, 6.4 (5.6) in head; eye 3.0, 3.1 (3.0) in head, 1.45, 1.55 (1.6) in postorbital part of head; maxillary somewhat expanded distally, with a broadly rounded margin, failing to reach joint of mandible by rather less than half diameter of pupil, 1.4, 1.5 (1.4) in head, 5.75, 6.1 (6.0) in standard length; cheek short and broad, definitely shorter than eye, its posterior angle

about 60°; postorbital part of head rather short, 8.0, 8.5 (7.9) in standard length; mandible 6.0, 6.1 (6.2); teeth in the jaws rather prominent, all with free points; gill rakers at angle of first arch about three-fourths length of eye, with strong serrations along inner edge, 18, 20 (19) on upper limb, and 23, 24 (24) on lower one of first arch; dorsal fin little elevated anteriorly, the longest rays not nearly reaching tip of last one if deflexed, origin of fin about equidistant from tip of snout and base of caudal; anal short, its origin under the beginning of the distal third or fourth of base of dorsal, its base 4.4, 4.7 (4.5) in standard length; ventral fin reaching about half way to origin of anal, inserted fully an eye's diameter in advance of vertical from origin of dorsal, and about equidistant between base of pectoral and origin of anal, 2.5, 3.0 (broken in the type) in head; pectoral rather long and pointed, failing to reach base of ventral by about diameter of pupil, inserted approximately equidistant from base of ventral and middle of eye, 1.4, 1.4 (1.4) in head, 5.6, 5.8 (5.9) in standard length; axillary scale of pectoral long, slender, failing to reach tip of fin by diameter of pupil, 1.7, 1.7 (1.6) in head.

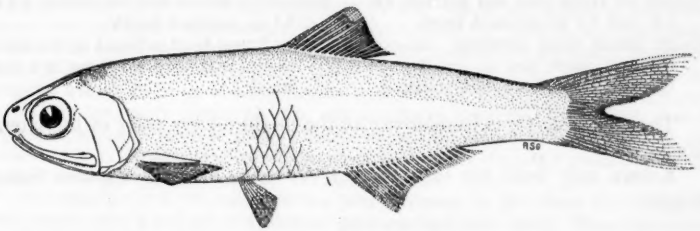

Fig. 4. *Anchoviella nitida.* From the holotype (USNM No. 143906), 77 mm. in standard length. (Drawing by Mrs. Ann S. Green.)

Color in alcohol plain straw; side of head bright silvery; a bright silvery lateral band present, notably narrower than eye, and not bordered above by a dark streak; upper surface of head and nape with dark punctulations, and a few on median line of back, some concentrated at base of upper lobe of caudal, and extending on caudal and dorsal fins; other fins plain, unmarked.

This species is represented in the collection by 3 specimens, taken at Victoria, State of Espirito Santo, which are respectively 95, 97, and 98 mm. in total and 73, 75, and 77 mm. in standard length. The largest one (USNM No. 143906) has been designated the type. The measurements and proportions based on the type are enclosed in parenthesis in the foregoing description.

This apparently new species is very close to *A. **hubbsi***, but differs slightly in several respects. The differences are shown in the parallel comparison that follows. As the specimens of the two species at hand are not of exactly the same size, those of ***hubsii*** (paratypes) being larger (97 to 100 mm. in standard length), some allowance for this difference perhaps should be made. However, it is not evident now that all the differences, especially those pertaining

to the mouth structures, are affected by the relatively small difference in age or size of the specimens. The two groups of specimens are from rather widely separated localities (Victoria and Rio Ribeira de Iguape). Therefore, specimens from intermediate localities, when they become available, may show intergradation.

A. nitida, n. sp.	*A. hubbsi*
Head rather large, its length 4.0, 4.1, and 4.3 in standard length; its postorbital length 7.9, 8.0 and 8.5 in standard length	Head usually slightly smaller, its length 4.3 to 4.7 in standard length; its postorbital length 8.3 to 9.6 in standard length
Maxillary rather long, 5.75, 6.0, and 6.1 in standard length	Maxillary shorter, 6.5 to 7.0 in standard length
Mandible long, 6.0, 6.1, and 6.2 in standard length	Mandible shorter, 6.6 to 6.9 in standard length
Teeth in the jaws rather prominent, all with free tips	Teeth in the jaws smaller, some of them more or less embedded, without free tips
Anal fin beginning under distal third or fourth of base of dorsal	Anal fin beginning about under middle of base of dorsal
Pectoral fin rather long and pointed, 5.6, 5.8, and 5.9 in standard length	Pectoral fin shorter and less pointed, 6.4 to 7.3 in standard length
Silvery lateral band definitely narrower than eye above base of anal fin, not bordered above by a dark streak	Silvery lateral band as broad as eye above base of anal, bordered above by a dark streak

The name, *nitida*, is in reference to the bright silvery color of the lateral band.

Known only from the type locality, Victoria, State of Espirito Santo, Brazil.

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Ichthyological Notes

NOTES ON GROWTH OF HYBRIDS BETWEEN THE SAUGER AND THE WALLEYE (*STIZOSTEDION CANADENSE CANADENSE* × *S. VITREUM VITREUM*) IN NORRIS RESERVOIR, TENNESSEE[1].—The natural occurrence of hybrid fishes has long been recognized by fishery investigators. In the Percidae, hybridization among the darters has been reported (Hubbs, 1926, Misc. Publ. Mus. Zool., Univ. Mich., 15: 60–61). Apparently unknown, however, is hybridization among the pike-perches. Although individuals of the hybrids between the sauger and the walleye (*Stizostedion canadense canadense* × *S. vitreum vitreum*) may have been caught by sportsmen earlier, it was not until 1943 that this hybrid was positively identified in Norris Reservoir. In that year two specimens were found among several thousand saugers and walleyes taken during experimental gill-netting operations. Several atypical walleyes and saugers had been noted before closer examination disclosed individual fish bearing distinct markings of both the walleye and the sauger.

Hybrids are easily recognized and generally appear to have walleye-like heads and sauger-like bodies together with pigmentation of the fins that is intermediate between the parent species. More precisely, they bear dorso-laterally on each half two large oval or saddle-shaped dark blotches, lengthened in the long axis of the body, a prominent color characteristic of saugers in Norris Reservoir. A white tip at the margin of the lower caudal lobe and sparse squamation of the cheeks, both as for walleyes, are also characteristic. The caudal fin is barred and the bases of the pectoral fins are darkly pigmented, although less so than on saugers. All interradial membranes of the spinous dorsal fin, although lacking the rows of black circular spots that are characteristic of saugers, are darkly and irregularly pigmented. The last membrane bears the black blotch that is typical of walleyes. Rows of spots, much as for saugers, appear on the soft dorsal fin. Scale counts, ray counts, and measurements of such other diagnostic features as body proportions have not been made by this writer.

Identification of a few specimens has been confirmed by Dr. Reeve M. Bailey. In more recent years a number of additional specimens have been noted. Three were taken in experimental gill nets on January 15 and 16, 1947. One was taken December 17, 1947, and another January 7, 1948.

TABLE I

GROWTH HISTORIES CALCULATED FROM SCALE MEASUREMENTS FOR FIVE HYBRIDS, *Stizostedion c. canadense* × *S. v. vitreum*

Date caught	Standard length (mm.)	Weight (gms.)	Sex	Age group	Calculated standard length (mm.) at age 1	2	3	4	5
12/17/47	444	1,368	F	V	218	356	423	438	444
1/7/48	383	923	?	IV	173	304	348	383	
1/16/47	411	1,057	F	III	154	323	411		
1/16/47	393	897	F	III	182	331	393		
1/15/47	336	572	?	II	213	336			
Average calculated standard length (mm.)					188	330	395	411	444
Average calculated total length (inches)					8.7	15.3	18.3	19.0	20.6

Average calculated growth of Norris Reservoir walleyes (Stroud, MS.) is 10.2 inches at the end of the first year and 16.5, 18.7, 19.9, and 20.8 inches at the ends of the next four successive years, with females growing more rapidly than males. Preliminary observations with respect to rate of growth of the sauger in Norris Reservoir, part of a study in progress, indicate that this species grows much less rapidly than the walleye in Norris Reservoir.

The data (Table I) suggest that growth of the hybrids in Norris Reservoir is intermediate between that of the parent species. The hybrids probably reach a much larger ultimate size than the sauger. This is evidenced by the report of a hybrid from a source considered reliable by both Dr. R. W. Eschmeyer and the writer. This fish, weighing

[1] Published by permission of the Tennessee Valley Authority.

about 6 pounds 9 ounces, was caught during late summer of 1947 by an experienced fisherman who brought in the mounted head for inspection. He was convinced he had caught a record sauger because of the distinct sauger-like coloration of the body of the fish. Both the sauger and the walleye are common in Norris Reservoir and this fisherman was familiar with both species. The head, however, was distinctly walleye-like in character, with respect to length of snout, size of eye, and nearly total lack of cheek scales. Careful questioning disclosed that the fish was undoubtedly a hybrid.—RICHARD H. STROUD, *Fish and Game Branch, Tennessee Valley Authority, Norris, Tennessee.*

"LEAPFROGGING" BY TOPSMELT AND SHARK[1].—The two observations reported here supplement those accumulated by Gudger (Fishes That Play "Leapfrog," Am. Nat., 78, 1944: 451–463, fig. 1). Obviously it is not uncommon for fishes to leap repeatedly over a floating object. Whether this action serves to remove ectoparasites or merely to provide an outlet for exuberant spirit—or both—are queries that come to mind.

The leaping may be compared with a habit very often displayed by many bottom fishes (and whales), namely the scraping of the sides against rocks and other submerged objects. That habit is ordinarily supposed to serve in the removal of ectoparasites.

On May 24, 1948, a calm day, with a group of colleagues at the end of the Scripps Institution pier near La Jolla, California, I observed fish engaging in this spectacular show. Repeatedly, for about one-fourth hour, one to several fish 6 to 9 inches long leaped over a floating stick about 2 × 15 inches. They usually went across the middle of the stick at right angles to its long axis. Sometimes they leaped clear; on other jumps they scraped their bellies or sides against the board, but they always went over. The urge seemed to be contagious, for the action was frequently repeated and once, toward the end of the performance, about 10 fish leaped in close succession, occasionally 2 at a time. After the whole group passed in one direction, one made a leap in the reverse direction. Thereafter, except for one skip over some floating strands of surfgrass (*Phyllospadix*), no further leaping was observed, despite the fact that the aggregation of fish involved remained near the surface. A smaller stick that was thrown in was similarly ignored. The habit had not previously been observed here although fish of the same subspecies had very often been observed at and near the surface about the same place, both during the day and while night-fishing with a strong light.

All the leapfrogging fish observed on this occasion (with the aid of binoculars) appeared to be adult kelp topsmelt, *Atherinops affinis cedroscensis* Hubbs. Like several other leapfrogging fishes reported by Gudger, this species is a member of the family of silversides, the Atherinidae. These and the other kinds reported to leap over floating objects ordinarily swim at or near the surface.

While we were watching the atherines leap over a stick, John D. Isaacs, of Scripps Institution, recalled having once seen a somewhat similar performance. In August, 1943, he watched a shark about 7 feet long as it leaped onto and then slid over a corrugated paper box, floating in the ocean about 60 miles off the mouth of Columbia River. After a half-dozen leaps the box was broken and the action ceased. Isaacs thought that the species was the great blue shark, *Prionace glauca* (Linnaeus), which is not uncommonly encountered at the surface in that vicinity. This identification is in line with expectation. Thus a surface-swimming shark may be added to the list of surface-swimming teleosts that leap onto and over floating objects. I am grateful to Isaacs for permission to report this observation.—CARL L. HUBBS, *Scripps Institution of Oceanography, University of California, La Jolla, California.*

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 393.

DETERMINATION OF SEX IN THE WHITE BASS, *LEPIBEMA CHRYSOPS*, FROM EXTERNAL CHARACTERS.[1]—Since the white bass, *Lepibema chrysops* (Rafinesque), frequently forms pre-spawning schools consisting largely of males, it is an aid to life history studies to be able to sex the live fish without injury. A review of literature of white bass fails to uncover reference to any technique of sexing white bass by external methods. Van Oosten (1942, Mich. Acad. Sci., Arts and Letters, 27: 307-334), working with Lake Erie white bass, presumably relied upon gonad examination since only part of his specimens were sexed. Howell (1945, Tenn. Acad. Sci. Jour., 20(1): 41-48), likewise, made no statement in regard to sexing white bass of the Tennessee Valley. According to Merriman (1941, Fish. Bul. U. S. Fish and Wildlife Service, 35(50): 20), except by an inspection of the gonads, there is no valid method of determining the sex of the striped bass (*Roccus saxatilis*).

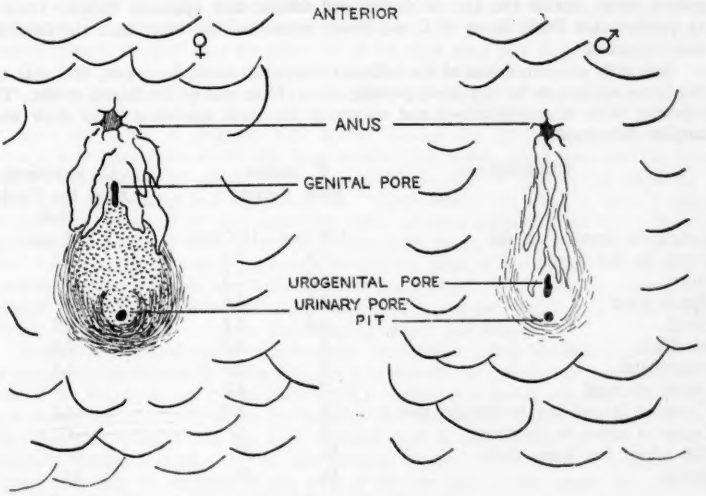

Fig. 1. Diagrammatic drawing illustrating the method of determining the sex of white bass by external observation. Only the females have a separate urinary (third) opening.

During the course of a life history study of the white bass in Spirit Lake, Iowa, it was discovered that the sexes could be distinguished externally in the larger fish. In females the genital ducts and the urinary tracts have separate openings; in males these systems discharge through a common urogenital pore (Fig. 1). The presence of a third opening in females can usually be detected at a glance. However, in males a small pit just posterior to the urogenital opening may appear similar to the urinary orifice of the females. Because of this, it is sometimes necessary for the examiner to use a blunt probe to establish the sex with certainty, especially in sub-adult fish. During the breeding season the female has a pronounced fringe of papilla-like folds around the anterior edge of the genital pore. This fringe is absent or only scarcely evident around the urogenital pore in the male. No attempt was made to sex individuals less than 10 inches in total length.

[1] Journal Paper No. J-1530 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project No. 764, and the Industrial Science Research Institute, Project No. 45, of Iowa State College; in co-operation with the Iowa State Conservation Commission and the U. S. Fish and Wildlife Service. Technical Paper No. 10 of the Iowa Cooperative Fishery Research Unit.

The presence of the separate urinary aperture in the female and of the urogenital pore in the male white bass was established by injecting gentian violet into the ducts. The anatomical structure of the female white bass does not differ from the description given for teleosts in general by Goodrich (1930, Macmillan and Co., Ltd., London: 704 and 710, Fig. 695).—WILLIAM F. SIGLER, *Department of Wildlife Management, Utah State Agricultural College, Logan, Utah.*

ON *CARANX NIGRIPINNIS* FROM THE PERSIAN GULF.—*Caranx nigripinnis* Day has been synonymized with *Caranx malam* (Bleeker), a ruling in which the writer has concurred until recent receipt of a specimen from the Persian Gulf, quite a different looking fish from two comparable ones of *C. malam* from Batavia to hand. It is more slender, with a straighter lower outline from chin to anal, less blunt head, longer, more pointed snout, smaller eye, and no similar well defined dark opercular blotch. There is no question that Day's figure of *C. nigripinnis* resembles this rather than the Batavian form examined.

It is only on examination of the technical characters, teeth, fin counts, etc., that the two forms are seen to be very close, possibly races of one widely distributed species. The following table of measurements and counts of the three specimens is to show their tangible differences.

Characters	*C. malam* from Batavia		*C. nigripinnis* from the Persian Gulf
Length to base of caudal	138 mm.	149 mm.	145 mm.
Depth in this length	2.8	2.6	3.2
Head	3.5	3.5	3.7
Eye in head	3.5	3.6	4
Snout	3.6	3.7	3.5
Maxillary	3	3.2	2.8
Interorbital	3	2.7	3.1
Depth of head	1.2	1.2	1.4
Curve of lateral line in straight part	2	1.9	2.3
Depth of curve in its chord	3	3	4
Gill rakers (on lower limb)	16	17	19
Scutes	56	58	63

To recapitulate, *C. nigripinnis* would seem to be a slenderer fish than *C. malam*, with less convex lower outline, less blunt head with profile less rounded down, more pointed, the snout longer than (versus equal to or slightly shorter than) a smaller eye, lower jaw more appreciably projecting, arch of the lateral line shorter in relation to the straight part, but less high; and to have a slightly greater number of gill rakers and scutes, and, at least, less well defined dark opercular blotch.

MATERIAL.—*C. malam*, AMNH No. 1564, 138 mm., Batavia, 1909, Owen Bryant; *C. malam*, AMNH No. 15946, 149 mm., Batavia, April 12, 1941, Inst. v.d. Zeevisscherij; *C. nigripinnis*, AMNH No. 18134, 145 mm., Persian Gulf, July, 1947, R. LeB. Bowen, Jr.—J. T. NICHOLS, *American Museum of Natural History, New York.*

Herpetological Notes

INTRODUCED FENCE LIZARDS ON STATEN ISLAND, NEW YORK.—Because of the frequent need for lizards as food for snakes in the collection of the Staten Island Zoo, it was deemed expedient to attempt to transplant specimens of *Sceloporus u. hyacinthinus* Green from southern New Jersey to a similar habitat on Staten Island's south shore. No lizard includes Staten Island in its natural distribution. A flat sandy area, supporting some pines, but mostly deciduous trees, was chosen in the section known as Rossville at a short distance from the shores of Arthur Kill, and on April 25, 1942, 19 specimens from Burlington and Ocean counties, New Jersey, were released. Of this original lot, there were 7 males, 6 females, and 6 immature and young. Additional releases were 5 females on May 17 and 3 females and 1 male on June 8, 1942, making a total of 28 introduced. All were marked by clipping the third toe of the left foot, except that the 5 females released in May have the third toe of the right hind foot clipped.

The war prevented observations on the success of this introduction until May 24, 1945, when Messrs. Wilmott and McCallion collected a single young of the year specimen—first evidence that the lizards were actually breeding in their new home. On April 22, 1946, the writer, in company with Messrs. Ranker and McCallion, found 4 specimens, 3 very large males and a very large female. The female and 1 male had the third toes of the left hind foot missing, thus representing the original releases, but the other 2 males were unmutilated and were obviously "Island Bred." On June 3, 1946, 4 adult females were found, all of them unmarked and 2 of them apparently gravid; 1 marked adult male, 3 young of the year and 1 yearling were caught and released. On April 10, 1947, I recovered 1 very large adult male bearing the mark of the original releases and 2 unmarked males, 1 female, and 1 hatchling of the previous year. All were marked and released. On June 17, additional specimens, 10 adult females and 1 male from Ocean County, New Jersey, were given distinguishing marks and released.

It must be admitted that a more frequent check of the colony has been prevented by the outrageous prevalence of poison ivy and it is intended to extend it to more attractive areas if the lizards do not spread more rapidly of their own accord. In any case, it has been shown that they will thrive and breed in this new habitat, there have been indications that the occupied area has been extended, and in one instance at least, a lizard originally released in April, 1942, was still living at the end of five years. It is hoped that further data may be obtained in this way on the life span of this species in a natural state.—C. F. KAUFFELD, *Staten Island Zoo, New York.*

NOTES ON A HOOK-NOSED SNAKE FROM TEXAS.—The Staten Island Zoo has had the good fortune to receive a specimen of the rare hook-nosed snake, *Gyalopion canum* Cope, probably only the ninth known specimen of this species, from Lt. L. W. Feagin of Biggs Field, El Paso, Texas. Lt. Feagin found the little snake while road cruising for snakes 15 miles north of El Paso, between El Paso and the Dona Ana firing range on the east slope of the Franklin Mts., El Paso County, Texas, at 8:10 P.M., September 3, 1947; weather clear; surrounding soil of mixed sand and gravel.

The specimen was loaned to Dr. A. H. Wright, and while in his possession apparently ate a garden spider. Predilection for an arachnid diet was confirmed subsequently on its return to the zoo when it ate 4 more spiders and a centipede. It refused millipedes consistently, also lizards, small snakes, frogs and newborn mice. Due to the difficulty of obtaining the proper food, the specimen was killed and preserved while still in good condition, and is No. 106 of the Staten Island Zoo's study collection. It shows the following characters: length 302 mm.; tail 51 mm.; head 12 mm. long, 8 mm. wide; 30 body blotches and 9 tail blotches; scale rows 19–17–17; ventrals 135; subcaudals 33; anal divided; sex male.

The peculiar "cloacal popping" described by Taylor (1931, COPEIA, 1931: 4–7) was produced by our specimen every time it was handled in the early days of its captivity, but ceased later. This snake used its specialized rostral to good advantage in burrowing in the sand of its cage.—C. F. KAUFFELD, *Staten Island Zoo, New York.*

THE PINE SNAKE IN KENTUCKY.—Funkhouser (1925, Wildlife in Kentucky: 119) mentions 2 specimens of *Pituophis m. melanoleucus*, the pine snake, from southeastern Kentucky, 1 from Corbin, Whitely County, and the other from Twila, Harlan County. Hibbard (1936, Trans. Kansas Acad. Sci., 39: 287) reports 4 *melanoleucus* observed on the north side of the Green River near Ollie, Edmonson County, Kentucky. One of these snakes (No. 50 in the collection of the Mammoth Cave National Monument Museum) was preserved and constitutes the first authentic record of *Pituophis* from the state. Stull (1940, Bull. U. S. Nat. Mus. 175: 52), Schmidt and Davis (1941, Field Book of Snakes: 160), and Stejneger and Barbour (1943, Bull. Mus. Comp. Zool., 93: 143) have not included this record and make no reference to the occurrence of this species in Kentucky. Another specimen of the pine snake (Stanford Natural History Museum No. 11612) was collected near Cadiz, Trig County, June 10, 1947, by Mr. Edward M. Ray of the Kentucky State Division of Game and Fish.

Comparison of Ray's specimen with the example collected by Hibbard, very kindly loaned me by Mr. Henry W. Lix, the naturalist at Mammoth Cave National Monument, proves that both fit Stull's diagnosis of the subspecies *melanoleucus*. The Ollie specimen slightly extends the range of variation for caudals and body blotches. It has 50 caudals as compared with the range of 52–66 given by Stull, but this low count may be due to the loss of a portion of the tail. The dorsal body blotches number 28 as compared to the previous known variation of 30–38. This last character is rather difficult to determine since the anterior blotches have merged leaving only a few light scales to mark the remnants of the interspaces between the blotches. In the following counts the first figure in each instance refers to the Ollie specimen, the second to the example from Cadiz. Scale rows at midbody 29, 29; ventrals 221, 213; caudals 50, 53; supralabials 8–8, 8–8; infralabials 12–13, 12–12; dorsal body blotches 28, 37; tail blotches 5, 6.

A second specimen from Trig County was collected by Mr. Ray along Turkey Creek near Cadiz and kept in captivity for some time. Mr. Lix has also informed me that a pine snake in bad condition, apparently from the Mammoth Cave region, was brought to him August 22, 1947. Neither of these snakes was preserved. Mr. Hix states that many local residents are familiar with the pine snake, which they know by various names.

The pine snake does not appear to be especially abundant in any part of its range, as witnessed by the few specimens available for Stull's revisional study. Its habitat in Kentucky seems to be limited to the bottom lands along the major rivers in southern Kentucky.—Jay M. Savage, *Natural History Museum, Stanford University, California.*

FOOD ITEMS OF RATTLESNAKES.—During the academic year of 1947–1948 I had in captivity a Willard rattlesnake, *Crotalus willardi* Meek, about 16 inches in length, and a spotted night snake, *Hypsiglena ochrorhyncha* Cope, of about the same length, but more slender. Both of these snakes fed readily on small lizards in the autumn. In winter lizards were not readily procurable and both individuals were for some time without food. The rattlesnake came through into April in good condition, however; while the night snake became thin and sluggish. It lay out in the open, though its previous habit had been to remain concealed in shavings under the water pan.

On April 19 a small lizard was placed in the cage of the spotted night snake, but no attention was paid to the prey. On April 22 the lizard was transferred to the cage of *willardi* and on April 23 it was accepted and eaten. On April 24, it became necessary to vacate the night snake cage, and the occupant was placed in the same small cage with the rattlesnake, where it continued to lie unconcealed. On the 25th it occurred to me to wonder whether the rattlesnake might not take the night snake as food if the latter were moved about in an alluring manner. Entering the room on the morning of April 26 to try out this idea, my question was answered by finding that the snake had disappeared, while the rattlesnake showed every evidence of having just completed a meal.

Concerning the food of the spotted night snake evidently little is known. Schmidt and Davis (1941, Field Book of Snakes: 260) say "Probably predominantly small lizards," which is borne out by the above.

Concerning the food of *C. willardi* the same authors say (p. 311) "Doubtless small mammals." This statement perhaps had its origin in Van Denburgh, who says (1922,

Reptiles of Western North America: 961) "A specimen from the Santa Rita Mountains contained an adult mouse."

I have long felt that the question of the food of new-born rattlesnakes of the larger species and many, if not most, individuals of the small species such as *willardi, triseriatus* (*pricei*), and *lepidus* (*klauberi*) is not satisfactorily answered by saying "small rodents," or "mice." I think it likely that they use more lizards than rodents for the following reasons: (1) in the high mountain habitat of the small species named, really small rodents are not plentiful; our smallest rodents, the tiny pocket mice, such as *Perognathus flavus,* do not occur at those altitudes, and shrews (if acceptable) are small enough, but very rare; (2) young lizards, and the smaller species, are plentiful and slender; (3) even in the "desert" where the larger *Crotalus* species live, new-born rattlesnakes would find lizards of suitable size much more plentiful than the smallest rodent species; (4) a good-sized tiger rattlesnake (*Crotaus tigris*), a species that has a relatively small head and neck, cannot swallow a full-grown house mouse; finally, (5) a new born *C. atrox* has an instinct for lizard prey; this is indicated by the following incident:

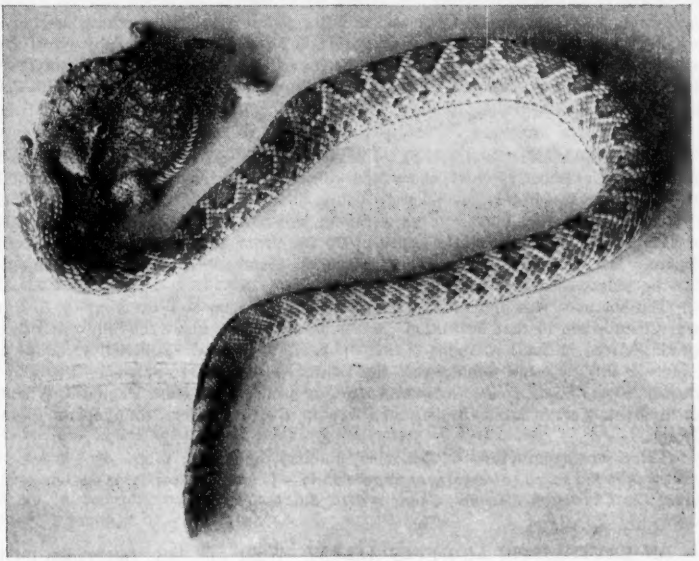

Fig. 1. Juvenile rattlesnake *Crotalus atrox,* killed by attempting to swallow a horned toad, *Phrynosoma solare.*

Some 15 years ago there was brought to me a recently born *C. atrox* that had attempted to swallow a horned lizard, *Phrynosoma solare.* It engulfed the head of the lizard, but the horns of the prey penetrated the body wall of the neck region of the rattlesnake, so that both predator and prey were locked together and perished in that position. There must have been a strong lizard-for-food attraction to lead to this tragedy. Miller (COPEIA, 1948: 67) points out the excellent protective characters of the horned lizard, and the resultant apparent lack of predatory enemies, and I am accordingly led to record this actual instance of the piercing of the body wall of a snake by the head spines of a horned lizard, which probably most herpetologists, like Miller, "have never seen." The protective character, however, in this instance was of no value to the prey.—CHARLES T. VORHIES, *Department of Entomology and Economic Zoology, University of Arizona, Tucson, Arizona.*

THE OCCURRENCE OF *AMYDA SPINIFERA ASPERA* IN FLORIDA.—Although neither the fourth nor fifth edition of Stejneger and Barbour's Check List (1939 and 1943) includes Florida in the range of *Amyda spinifera aspera* Agassiz, this turtle is apparently wide-spread and abundant in the western panhandle of the state. There are 3 Florida specimens in collections as follows: American Museum of Natural History No. 44621 from the Blackwater River near Milton, Santa Rosa County; Carnegie Museum No. 20299 from the Chattahoochee River, 8 miles southeast of Butler, Jackson County; and Museum of Comparative Zoölogy No. 38436 from the Ochlockonee River northwest of Tallahassee, Leon County. So far as I can tell, these turtles differ in no important respect from typical *aspera,* as exemplified by material from farther north and west.

I have talked with a number of commercial fishermen who carry on their activities in the larger rivers of western Florida. The majority of them seem to be well acquainted with these turtles, which they catch on trot lines set for catfish on the bottom of the river beds. They are agreed that this form is fairly common in the deeper rivers of the panhandle.

There is a published record of *aspera* from Florida obviously due to a *lapsus* that should be corrected. In the legend of Plate 16 of Stejneger's posthumous study of soft-shelled turtles (1944, Bull. Mus. Comp. Zoöl., 94) a cotype in the Museum of Comparative Zoölogy (MCZ 1622) is stated to be from Lake John, Florida. This specimen is listed in the museum catalogue as having come from Lake St. John, Mississippi.—Coleman J. Goin, *Department of Biology, University of Florida, Gainesville, Florida.*

THE SALAMANDER *AMBYSTOMA MABEEI* IN SOUTH CAROLINA.—On the morning of November 29, 1947, the writers collected a specimen of Mabee's salamander, *Ambystoma mabeei* Bishop, in Berkeley County, South Carolina, 18 miles north northeast of Charleston. The amphibian was taken from under a half-submerged stump on the margin of a tupelo-cypress bottom at a spot not 20 feet from a paved road, South Carolina Highway 511, which cuts the bottom at this point. Numerous small bottoms of this type dot the pine woods that border the highway.

This specimen was presented to the Charleston Museum and identified by E. Burnham Chamberlain of that institution. So far as the writers know the only other record for this species in South Carolina is that of A. H. Wright, who collected 12 adults and 1 juvenile in Charleston County near the Edisto River in 1934. Sherman C. Bishop in his *Handbook of Salamanders* lists this species as being known from Dunn and Wilmington counties, North Carolina; Charleston County, South Carolina; and Liberty County, Georgia.

Three subsequent visits, in December, January, and May, to the spot where this adult was found failed to reveal any more *mabeei.*—James E. Mosimann and George B. Rabb, *The Charleston Museum, Charleston 16, South Carolina.*

AN ERYTHRISTIC *LIODYTES ALLENI.*—While collecting watersnakes on the roadfill across Payne's Prairie, Alachua Co., Florida, the night of March 20, 1948, I came upon an erythristic adult male *Liodytes alleni* Garman. It had evidently come up on the road to warm itself in company with numerous *Natrix sipedon pictiventris, N. cyclopion floridana, Seminatrix pygaea,* and other *Liodytes.*

Instead of the usual yellow coloration, the belly and stripes of the specimen are Coral Red (Ridgway). The red color is apparently spread over the entire body, but stands out most prominently in the usual yellow areas.

The snake was put in an aquarium, in which were placed crayfish (*Cambarus*), salamanders (*Desmognathus, Triturus, Pseudobranchus*) and minnows (*Heterandria, Gambusia*). All food was refused, as it was also by normal specimens, and the snake died during the fourth week in captivity.

This was the only case of erythrism observed in 250 specimens of *Liodytes.* The snake was preserved in formalin, which is slowly fading the red color. Amaral (1932, Notas sobre chromatismo de ophidios; Mem. Inst. Butantan, 7: 79) discusses an erythristic *Pseudoboa trigemina,* whose red color was found to be extremely soluble in solutions containing either glycerin or ethyl alcohol.—Byrum W. Cooper, *Department of Biology, University of Florida, Gainesville, Florida.*

REVIEWS AND COMMENTS

ISLAND LIFE.—A Study of the Land Vertebrates of the Islands of Eastern Lake Michigan. By Robert T. Hatt and Josselyn Van Tyne, Laurence C. Stuart, Clifford H. Pope, and Arnold B. Grobman. Cranbrook Institute of Science, Bull. 27: xi + 179 pp., 43 figs., 1 map. $4.00.—The attention of herpetologists was focussed on the interest of the islands in the North American Great Lakes by the description of the Lake Erie water snake, *Natrix sipedon insularum* Conant and Clay, in 1937. The existence of so distinct a form, quite evidently developed in the geologically short time elapsed since the retreat of the continental glacier, is a matter of broad biological interest, what with the development of societies for the study of speciation and of separate journals for reports on topics of this precise nature (e.g., *Evolution,* adv.). Thus the examination of the vertebrate fauna of the islands in northeastern Lake Michigan afforded a project of some interest, although only remotely comparable with the biological interest of oceanic islands.

It is thus somewhat disappointing to report that no such well marked exemplars of speciation processes were turned up, and the published account appears somewhat pretentious for a report of essentially negative results. There are, indeed, some clues to the effect that the islands of western Lake Michigan, excluded from this survey (I fear, on grounds of state patriotism), might be more rewarding. The field parties seem to have operated more in the tradition of field collecting of a past generation than on more quantitative and, in general, ecological principles. Species are 'absent', 'rare', or 'common'. One would like to know *why* absent? (which is partly answered), *how* rare? and *how* common? Furthermore the technique of study by field parties, as compared with the establishment of resident naturalists, is somewhat suspect, as is the operation of the "Museum Expedition" itself, a matter on which I am in complete agreement with Alfred Russell Wallace (Island Life, 2nd Edition: 7, footnote).

All this seems a captious and perverse reaction to so handsome a volume. We have far too few regional faunal lists in book form, and such lists are especially desirable when supplied with a proper geographic and historical introduction. Within the limitations of its data, *Island Life* reports interesting ecological results, with a chapter on modifications of habits and a well-thought-out essay on the factors of distribution.

In any case, I hope that my herpetological colleagues, most of whom appear to be as prone to disregard Agassiz' dictum "Study nature, not books" as was Agassiz himself, will not be deterred from acquiring this volume.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago 5, Illinois.*

EDITORIAL NOTES AND NEWS

Summary of the 1948 Meeting

THE twenty-eighth annual meeting of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS was held at New Orleans, Louisiana, March 26 to 29, 1948. Registration opened in the Jung Hotel, Thursday evening, March 25, and was continued Friday morning, March 26.

Sessions of March 26

PRESIDENT HUBBS opened the sessions at 10 A.M. in Dinwiddie Hall, Tulane University, at which time he appointed the following committees: *Prize Award*—GEORGE A. MOORE, MILTON B. TRAUTMAN, CHARLES M. BOGERT, GEORGE P. MEADE; *Photographic Award*—ROGER CONANT, ISABELLE CONANT, FRED H. STOYE; *Resolutions*—DORIS M. COCHRAN, EDWARD C. RANEY. The following papers were then read:

1. **A new poecilid fish of the genus *Gambusia*, from Southern Florida.—Luis R. Rivas and John W. Sutton.**
2. **Abnormal scale patterns in fishes.—Gordon Gunter.**
3. **The fishes of Great Slave Lake and Great Bear Lake of Canada.—W. A. Kennedy.**
4. **Variation and systematic significance of vertebral count in the darters (Etheostomatinae).—Reeve M. Bailey and William A. Gosline.**
5. **On the nature of variability in certain meristic characters of fishes.—William A. Gosline.**
6. **The life history of the speckled trout at the northern limit of its range.—K. H. Doan.**
7. **The subspecies of the shielded darter, *Hadropterus peltatus*.—Edward C. Raney and Royal D. Suttkus.**

At the conclusion of the morning session the group was transported by bus to Audubon Park. As we entered a large room for luncheon we were greeted by gracious hostesses proffering cooling beverages. And what a sight met our eyes—rows of large ice cakes heaped with tempting stacks of crabs, shrimps and crayfish! Inland-dwellers accustomed to seeing only three small shrimps in a cocktail had looks of pleased incredulity on their faces as they ate their fill. And then, when we had feasted to repletion, MR. GEORGE DOUGLAS, Director of Audubon Park, asked us to find seats at the tables to partake of still further delicacies! Those of us previously acquainted with New Orleans had past memories superseded by the present actuality, and newcomers learned that Southern hospitality is as stomach-filling as it is heart-warming.

Following the luncheon, DIRECTOR DOUGLAS welcomed the Society to Audubon Park and introduced some of those who had assisted in entertaining us so bountifully. We then strolled beneath magnificent live oaks to the zoo and acquarium, which shortage of time impelled us to tour hastily.

The afternoon session convened, understandably late, at 3 P.M. with MR. BOGERT presiding, for the reading of the following papers:

8. **Cytological observations on the ophidian ovary.—Brahma S. Kaushiva.**
9. **Notes on the young of the blue racer.—Ernest A. Liner.**
10. **Phenomena associated with color and pattern in southwestern reptiles.—Charles M. Bogert.**
11. **The distribution of species of Amphiumae.—C. L. Baker.**
12. **Distribution of the neotenic *Eurycea* of central Texas.—Floyd E. Potter, Jr. and Alvin G. Fleury.**
13. **A rapid smear technic for salamander chromosomes.—James Kezer.**

Governors' Meeting

THE Board of Governors' meeting in Gibson Hall was called to order by PRESIDENT HUBBS at 4.45 P.M., with 17 Governors and additional members of the Local Committee in attendance. The reading of the 1947 minutes, previously published in COPEIA, was dispensed with. The 114 persons added to the rolls in the seven-month period from Aug. 16, 1947, to March 15, 1948, were formally elected to membership. Ten Governors, JOSEPH R. BAILEY, ROGER CONANT, RAYMOND B. COWLES, MYRON GORDON, WILLIAM A. GOSLINE, WILLIAM J. HAMILTON, JR., NORMAN E. HARTWEG, WILLIAM C. SCHROEDER, E. H. TAYLOR and MILTON B. TRAUTMAN, whose terms expired at this meeting, were re-elected to serve until 1953 and GRACE L. ORTON was elected to fill a vacancy in the class of 1952. The SECRETARY read a letter from J. L. B. SMITH expressing appreciation of his election as an Honorary Foreign Member in 1947. Following nominations for the single vacancy in the roster of Honorary Foreign Members, PROF. LORENZ MÜLLER was elected.

The SECRETARY reported that the Society had 31 fully paid Life Members, 10 partly paid Life Members, and $3,661.85 in the Endowment Fund. He reported, also, that the Special Gift Fund totalled $2,800.00. VICE-PRESIDENT STOYE reported that two grants, totalling $128.00, were made from the Revolving Research Fund during the year, leaving a balance of $1,548.25. The TREASURER was empowered to send 25 pounds, as a gift from the Society, toward the cost of the 1947 *Zoological Record*.

The SECRETARY announced that the Society had received a generous donation of $500.00 from LIFE MEMBER TRACY I. STORER, to be expended in any way that the Board

of Governors determines. After considerable discussion of possible productive uses of this sum the Board voted to authorize the officers of the Society to decide upon the proper use of the money. The Board also passed a motion thanking DR. STORER for his generous gift and for the confidence he had reposed in the Board.

The Department of State's invitation to the Society to send a delegate to the Inter-American Conference on Conservation of Renewable Natural Resources, to be held at Denver, Colorado, Sept. 7 to 20, 1948, was considered and DR. WALFORD was selected as our delegate. He was further authorized to designate as a substitute, in the event he cannot attend, some one attending in connection with regular duties, since the Board declined to pay the expenses of a delegate to such a protracted meeting.

The SECRETARY reported that 388 members had voted in favor of the Society joining the American Institute of Biological Sciences, 14 were agreed in principle but objected to the assessment duplication, and 39 were opposed. KARL P. SCHMIDT, our delegated representative, reviewed the actions taken at the spring meeting of the Institute.

The officers were empowered to select the meeting place for 1949. A proposal that the Society issue membership cards was defeated. After some discussion of exchanges of COPEIA the meeting adjourned at 6:15 P.M.

Annual Smoker

THE members gathered in a large auditorium in the French Quarter at 9 P.M. for the annual smoker. During the evening several unique entertainment features were presented. A special program dedicated to the Society and MC-d by MR. PERCY VIOSCA, JR. was broadcast over station WRCM. Those present evinced more interest in the Louisiana frog voices previously recorded by MR. VIOSCA than in their own voices recorded that evening. In place of ICHTHERPS, victim of rising costs, a humorous tabloid news sheet was sold by charming newsgirls. After some dancing, much conversation, and varied refreshments the group disbanded early in anticipation of the field trip on the morrow.

Activities of March 27

AT 8 A.M. a large crowd boarded two chartered buses for an all-day and half-night trip around Lake Pontchartrain. Levees, spillways, crevasses, bayous, swamps, terraces, plantations, and oil, sugar, and strawberry producing areas, and other points of interest were included in the itinerary. The tour, under the able leadership of MR. VIOSCA, whose exhaustive knowledge of the region was so much in demand that he had to migrate from one bus to the other, provided an unexcelled opportunity to observe many of the varied ecological conditions represented in this complex region. Frequent stops were made for observation and collecting. Each person was provided with a detailed and authoritative synopsis of the Saturday and Monday trips, prepared by the Field Trip Committee under MR. VIOSCA's chairmanship.

At noon the party reached Gramercy where we were the guests of the Colonial Sugars Company and its general manager, our LIFE MEMBER GEORGE P. MEADE, ably assisted by many of his executive staff and their wives. On a lovely lawn, shaded by exotic trees, we feasted on such famous creole dishes as crawfish bisque and jambalaya prepared by Colonial Sugars' officials who had labored long (1800 crawfish were stuffed for the bisque!) and expertly to make this luncheon the gastronomic triumph that it was. During luncheon each table was photographed informally by the Company photographer; afterward a group photograph was taken. Finally, each guest was presented with a confection of the region, a praline made from sugar and pecans produced on the Colonial property. We then visited MR. MEADE's backyard, whence have come so many important life history observations, to view his collection of local amphibians and reptiles in outdoor cages.

The afternoon tour took us first through river bottom forest, then pine flats, with longleaf pine hills in view to the north, and ended at Mandeville. Here, at Fontainbleu State Park, on the north shore of Lake Pontchartrain, the Annual Banquet was held. The menu featured many Louisiana specialties and one delicious novelty, filet d'Amphiuma. An unexpectedly large crowd taxed the facilities so greatly that the presidential address had to be omitted. At the conclusion of festivities the rapidly falling temperature induced the more sensible members to return directly to New Orleans. The second bus, crammed

with hopeful herpetologists, continued over the route scheduled for the amphibian breeding trip but few frog voices were heard because of the Yankee weather.

Sessions of March 28

THE morning session was called to order by PRESIDENT HUBBS at 10:30 A.M. The following papers were presented:

14. Ecology of fossil and recent fish remains.—Lore Rose David.
15. Effects of floods, droughts, and seasons upon darter populations in a riffle of a central Ohio stream.—Milton B. Trautman.
16. The role of applied ecology in Canada's greatest fisheries survey.—K. H. Doan.
17. The effect of exploitation on a virgin fish population in North America's fifth largest lake.—W. A. Kennedy.
18. On the urgent need of fisheries exploration in the western Gulf of Mexico.—J. L. Baughman.

Following luncheon at the Tulane Cafeteria the afternoon session convened, with VICE-PRESIDENT STOYE presiding, for the deferred Presidential Address on "Hybridization in Fishes" by PRESIDENT HUBBS. The following papers were then read:

19. The herpetological collections of the West Virginia Biological Survey.—N. Bayard Green.
20. The poisonous snakes of the United States and the treatment of their bites.—M. L. Crimmins.
21. Fauna of the Everglades and the Key West Islands.—Lewis H. Babbit (movies).

Business Meeting

VICE-PRESIDENT STOYE called the annual business meeting to order at 4:15 P.M. The minutes of the 1947 meeting, previously published in COPEIA, were not read.

The SECRETARY reported that 114 members were obtained in the seven months since the previous meeting; 18 resigned, 35 were dropped, and 1 moved without leaving a forwarding address. The losses totalled 54, resulting in a net gain of 60 members which increased the total membership to a new high of 884. Twenty-two new subscriptions were obtained and ten were discontinued, the net gain being 12, making a subscription total of 231. The combined total of members and subscribers was 1,115 on March 15, 1948. Geographical tabulations indicated that 181 copies of COPEIA go to 34 foreign countries, Canada leading with 43, followed by the U.S.S.R. with 29 and Great Britain with 17. Domestic copies total 934, California leading with 131, followed by New York with 121 and Michigan with 73. The sole Delaware member was lost during the year, making this the only state with neither a member nor subscriber. The SECRETARY commended the Membership Committee for the major part it had played in obtaining new members and subscribers. The SECRETARY then announced that he had assumed office in 1931 when the total mailing list of COPEIA was 431, that he had thoroughly enjoyed growing up with the Society and that he had hoped to complete a 20-year term. Pressure of other duties, which made it impossible for him to dispatch Society business promptly, dictated that he tender his resignation after 19 years' incumbency. He thanked the members for their consideration and co-operation during his term and stressed the fact that close contact with the far-flung membership had more than compensated him for the often onerous duties of his office.

The SECRETARY summarized the TREASURER'S report for the calendar year 1947, as follows: receipts, including $1,043.89 from the sale of back numbers and $1,077.91 in payment of reprint bills, totalled $5,659.57; expenditures, including $3,194.03 for publication of COPEIA and $1,089.39 for reprints ordered by authors, totalled $4,912.36.

The SECRETARY next summarized the actions taken at the Board of Governors' meeting.

Prior to the New Orleans meeting, in accordance with a recommendation made at the 1947 meeting, PRESIDENT HUBBS appointed as a *Nominating Committee* FRED R. CAGLE, Chairman, W. I. FOLLETT, W. A. GOSLINE, RAYMOND E. JOHNSON, K. P. SCHMIDT, and COLEMAN J. GOIN. This Committee, on which GRACE L. ORTON replaced COLEMAN J. GOIN, who was not in attendance, presented its report. There being no nominations from the floor, the report was accepted and the following officers duly elected: JOHN TREADWELL NICHOLS and HELEN T. GAIGE, *Honorary Presidents*; M. GRAHAM NETTING, *President;* CHARLES F. WALKER, F. H. STOYE, MILTON B. TRAUTMAN, *Vice-Presidents;* EDWARD C. RANEY, *Secretary;* LOREN P. WOODS, *Assistant Secretary;* ARTHUR W. HENN, *Treasurer;* HELEN T. GAIGE, *Editor-in-Chief;* GERALD P. COOPER, *Ichthyological Editor;* KARL P. SCHMIDT, *Herpetological Editor;* REEVE M. BAILEY, E. R. DUNN, NORMAN HARTWEG, RAYMOND E. JOHNSON, and ROBERT R. MILLER, *Editorial Board;* WALTER L. NECKER, *Historian.*

EDITOR SCHMIDT reported on the progress of the sixth edition of the "Check List of North American Amphibians and Reptiles," to be issued by the Society. His report was approved.

Following discussion and upon motion by MR. NECKER it was voted that the membership and subscription list of the Society should be published in COPEIA this year.

The *Prize Award Committee* announced that the first prize for the best student paper in herpetology had been awarded to JAMES KEZER for paper no. 13 and the second prize in herpetology to BRAHMA S. KAUSHIVA for paper no. 8. There were no student papers in ichthyology and hence no prizes were awarded in this field.

The *Photographic Award Committee* awarded the first prize of $25.00 to EDWARD C. RANEY, and announced that the second prize ribbon went to PAUL D. R. RUTHLING, and the third prize ribbon to JAMES KEZER.

The meeting adjourned, with a rising vote of thanks to the officers, at 5:20 P.M.

Activities of March 29

AT 7 A.M., after hastily gulped breakfasts, a large group assembled at the Jung Hotel for a caravan and boat trip down the Mississippi Delta. MR. VIOSCA served as our informative guide en route to Pointe a la Hache, where we crossed the river by ferry, and on to Port Sulphur. Here, through the courtesy of MR. LEANDER H. PEREZ, we became the guests of the Freeport Sulphur Company, going by launch to the "mining" area, visiting the various installations, enjoying a pleasant lunch which the company provided, and even being afforded opportunities for some collecting before returning to Port Sulphur in the early afternoon. Here some of us with evening departure schedules said "farewell" and returned to New Orleans by car. A smaller and more fortunate contingent, led by MR. VIOSCA, drove on to Venice where they embarked for a boat trip and collecting excursion to the delta marshes.

This report would be incomplete without paying tribute to the LOCAL COMMITTEE for the excellent program of sight-seeing and entertainment provided for the wives of members on Friday and Sunday, the two days during which formal sessions were in progress. The photographic exhibit was a most worthwhile feature, also, and all who made the trek across the Tulane campus to view it were amply rewarded for having done so. Another excellent inovation was the inclusion of abstracts of papers in the printed program. (Members who could not attend may obtain copies by sending a stamped, self-addressed envelope to either the President or the Secretary.)

The New Orleans meeting will never be forgotten by the 134 persons who signed the attendance roster, and the *Resolutions Committee's* report, herewith appended, was adopted with an enthusiasm that bespoke unanimous appreciation of the hospitality extended so prodigally and graciously.

Whereas, the Twenty-Eighth Annual Meeting of the American Society of Ichthyologists and Herpetologists, held at Tulane University in New Orleans from March 26 through 29, 1948 has been successfully completed:

Therefore, Be it Resolved: 1) That the members of this Society express their deepest appreciation for the unlimited courtesy and hospitality extended to them by the *Local Committee*: FRED R. CAGLE (chairman), WALTER MOORE, IRA GEORGE, PERCY VIOSCA, GEORGE PENN, E. H. BEHRE, E. S. HATHAWAY, HENRY CHASE, A. H. CHANEY, GEORGE P. MEADE, and the wives of some, as well as their other assistants: 2) That we owe especial thanks to MR. GEORGE P. MEADE, manager of the Colonial Sugars Company and members of his staff, for their splendid hospitality on the occasion of our visit to Gramercy and to MR. GEORGE DOUGLAS, Director of Audubon Park, for a very enjoyable luncheon and festive get-together at Audubon Park: 3) That thanks are due to the following organizations: TULANE UNIVERSITY, for its hospitality, for the use of many of its facilities and for the time devoted to meeting arrangements by several of its staff; the FREEPORT SULPHUR COMPANY, for lunch and a tour of its installations at Port Sulphur; the U. S. FISH AND WILDLIFE SERVICE, for use of a boat on the Delta trip; the LOUISIANA STATE PARKS COMMISSION and MR. WILLIAM WELLS, for use of Fontainbleau State Park; RADIO STATION WRCM and its engineers for broadcasting a special program dedicated to the Society; the staff of the GRUNEWALD MUSIC HOUSE for the loan of a radio; and the ZETZ 7-UP BOTTLING COMPANY, and MR. HENRY BROAD, JR., for use of an auditorium for the smoker: 4) That the LOUISIANA STATE UNIVERSITY deserves our thanks as joint host with TULANE UNIVERSITY: 5) That we are likewise appreciative of the programs planned for the entertainment of wives and friends of members by the faculty members' wives and others.

—M. GRAHAM NETTING, *Past Secretary*.

News Notes

A LATE notice, but it is of considerable interest that DR. WILBERT M. CHAPMAN has taken leave as Director of the School of Fisheries at the University of Washington to become Special Assistant for Fisheries in the United States State Department. It was announced by ROBERT A. LOVETT, under Secretary of State, that DR. CHAPMAN will have a free hand in developing treaties and agreements with foreign countries in respect to fisheries matters.

DR. HSIEN WEN WU, Institute of Zoology, Academia Sinica, 320 Yo Yank Road, Shanghai, China, has communicated to DR. CARL L. HUBBS his desire to resume an exchange of publications with American ichthyologists.

DR. NELSON G. HAIRSTON received his PhD (ecology of salamanders) from Northwestern University during 1948 and is now Instructor in Zoology at the University of Michigan.

MR. HERMAN KLEEREKOPER (see COPEIA, 1947 (4): 294) has joined the Zoology Department, McMaster University, Hamilton, Ontario, effective September 1, 1948, to teach limnology and physiology.

Recently visiting fisheries laboratories in the United States, and attending the 1948 American Fisheries Society meetings in Atlantic City, was MR. FERNANDO OBREGON, Chief of Technical Office, Office of Fisheries, Navy Department, Mexico City, Mexico.

DR. W. HARRY EVERHART has been appointed Assistant Professor of Zoology at the University of Maine, Orono, to give courses in ichthyology and fish management and to do part-time research for the State of Maine Department of Inland Fisheries and Game.

DR. GEORGE A. ROUNSEFELL, stationed at the University of Maine, Orono, and working on rehabilitation of runs of the Atlantic salmon, has as an assistant MR. LYNDON H. BOND, a former graduate of the Cooperative Wildlife Research unit at that institution.

W. F. CARBINE, recently returned to the states from the Philippine Islands, is now Chief of the Section on Inland Fisheries, United States Fish and Wildlife Service. DR. EARL S. HERALD, also recently back from the Philippines, is with the Steinhart Aquarium, Golden Gate Park, San Francisco, California.

DR. ALBERT W. C. T. HERRE has accepted a position in the University of Washington, School of Fisheries, Seattle.

DR. ROBERT R. MILLER, Associate Curator of Fishes, United States National Museum, currently on an expedition to Arnhem Land, Australia, has accepted the position of Associate Curator of Fishes, Museum of Zoology, and Assistant Professor of Zoology, University of Michigan, effective December 13, 1948.

DR. A. S. HAZZARD spent the month of October, 1948, with the State of California Division of Fish and Game as a consultant on plans for extensive new capital outlay for fish management activities.

MR. VIANNEY LEGENDRE, Biologist, Quebec Biological Bureau, is continuing his education at the University of Michigan Museum of Zoology, where he will undertake a taxonomic revision of the Esocidae as a doctoral dissertation.

DR. WILLIAM C. STARRETT completed his doctor's degree at Iowa State College during 1948 and is now Associate Aquatic Biologist, Illinois State Natural History Survey, Urbana, Illinois.

DR. JOHN FIELD, physiologist at Stanford University, has begun an investigation of the mechanisms by which small cold-blooded animals adapt themselves to climatic extremes of heat and cold, under the Office of Naval Research. Dr. Field will study related forms of life in Alaska, in the more temperate areas of the Pacific Coast, and in the tropical zone of Panama. CLARENCE N. PEISS, of Palo Alto, California, will serve as research assistant in the project, remaining at the Arctic Research Laboratory, Point Barrow, Alaska, until next March.

DR. L. C. STUART, University of Michigan, will be engaged in field studies of Guatemalan reptiles and amphibians from February 1, 1949 to August 31.

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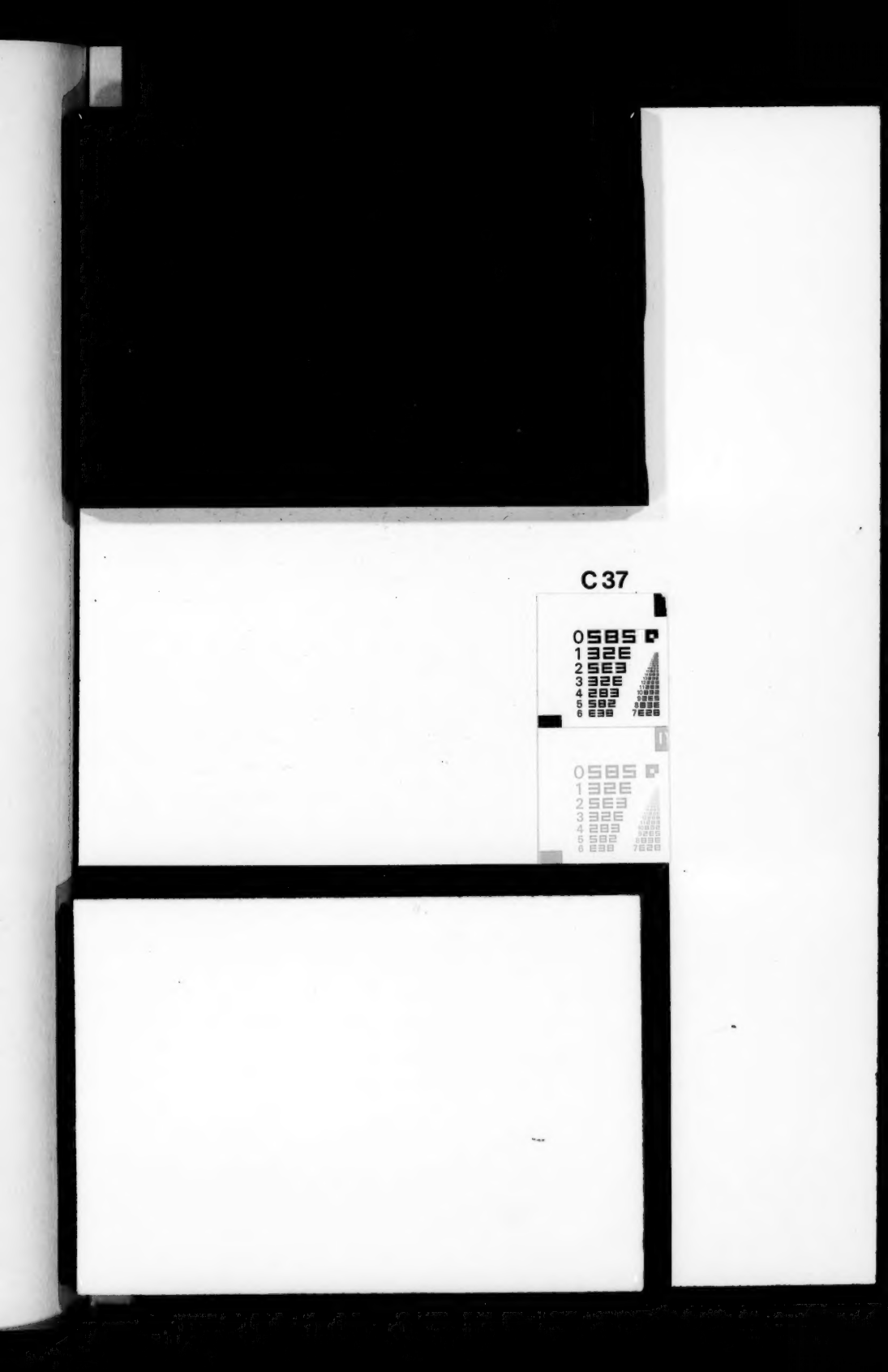
ΒΑΤΡΑΧΟΣ
ΕΡΠΕΤΟΝ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